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ABSTRACT

To identify problems regarding economic development, the Committee for Scientific and Technical Personnel conducted an educational and occupational survey of each member country of the Organisation for Economic Cooperation and Development (OECD). The specific purpose of the surveys was to gather comparative data on the training and utilization of technicians in each member country. Major sections of each survey are: (1) The Structure of the Educational System, (2) Training of Technicians and Other Technical Manpower, and (3) Functions of Technicians. Related surveys for each of the following countries, Canada, Denmark, Spain, France, Netherlands, Switzerland, Yugoslavia, United Kingdom, and Italy, are available in this issue as VT 015 716-VT 015 723 and VT 015 725 respectively. (JS)

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SCIENTIFIC AND TECHNICAL PERSONNEL

THE EDUCATION, TRAINING AND FUNCTIONS OF TECHNICIANS

PORTUGAL

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DIRECTORATE FOR SCIENTIFIC AFFAIRS
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

SCIENTIFIC AND TECHNICAL PERSONNEL

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PREFACE

The O.E.C.D. Committee for Scientific and Technical Personnel has given considerable attention to the question of technician training and utilisation which is a key problem in the economic development of Member countries, and has on several occasions drawn attention to the need for an adequate supply of and proper training for skills at this level.

To clarify the situation as far as possible and to establish a solid base for discussion, the Committee has instituted a series of surveys in Member countries describing and analysing training conditions.

The material obtained is classified according to a standard pattern throughout, so that comparisons can be drawn between countries. The completed surveys were used as basic working documents for "Confrontation Meetings" between two or more countries. These meetings were held under a neutral chairman and were attended by teams of specialists from the participating countries. Delegates discussed each other's training systems and the various problems which arise and endeavoured to reach conclusions on questions of policy and to find solutions to technical difficulties.

The present publication, the tenth of a series, was prepared by the O.E.C.D. Secretariat the responsibility being with Mr. S. Syrimis, Consultant to the Directorate for Scientific Affairs. It incorporates information already available at O.E.C.D. and in particular in the original survey carried out by a joint F.E.A.N.I./E.U.S.E.C.(1) Committee, supplemented by on-the-spot investigation.

The Secretariat wishes to acknowledge its indebtedness to the Portuguese Educational Authorities for their help and co-operation in the preparation of this report.

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(1) F.E.A.N.I.: European Federation of National Associations of Engineers.

E.U.S.E.C.: Conference of Engineering Societies of Western Europe and the United States of America.

Part One

THE STRUCTURE OF THE EDUCATIONAL SYSTEM

I. GENERAL DATA - THE PLACE OF TECHNICAL EDUCATION IN THE EDUCATIONAL SYSTEM

1. The traditional Portuguese educational system is based on four years compulsory primary schooling. A recent Act (1964), however, provides for the extension of the compulsory period to six years. The new system affects all those, who in the school-year 1964/65 were attending the first grade for the first time, or were repeating it after failing to gain promotion to the second grade. Beginning with the school-year 1968/69, the pupils who end the elementary section of the primary school course (1st to 4th grades inclusive) can complete the remaining two years of compulsory schooling either by attending a complementary cycle of the primary course (5th and 6th grades) or a preparatory secondary-level course, which is to substitute the present first cycle of the high school course and the preparatory vocational cycle (paragraph 12).

2. The "productivity" of the educational system is low at both the primary and secondary levels. During the 1961-1962 school year, for instance, about 880,000 school-age pupils attended primary school; of these, about 216,000 repeated a year. Wastage for some of the secondary courses is of the same magnitude, the main reasons for this being:

(i) inadequate facilities;

(ii) badly adjusted curricula;

(iii) instability of teaching personnel, especially those outside the quota of permanent posts;

(iv) difficulty in transferring pupils from one type of education to another;

(v) slow adaptation to economic and social change;

(vi) choice by the pupils of courses preparing for a particular career before they are sufficiently mature(1).

3. Under the 1933 Constitution of the Portuguese Republic, private schools which correspond to State schools may be established freely. They are subject to State inspection, and may be subsidised by the State and authorised to grant diplomas, provided the standard of their teaching staff and curricula is not lower than that of the corresponding public institutions (Article 44). Private education occupies an important place in secondary education, particularly in the general education stream, where 401 of the total 446 general secondary schools (school year 1964/65) belong to church or private organisations and individuals. These schools absorb nearly 59 per cent of the total general-secondary school population. A global picture of the situation is given in Table 1.

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(1) See Mediterranean Regional Project: Portugal, O.E.C.D., Paris 1966.

Table 1

Enrolments in private education (1964-65)

(as a percentage of total in each type of education)

1.	Primary	4.0(1)
2.	Secondary	47.5
	of which:	
	(i) general	(58.7)
	(ii) technical and other vocational	(6.6)
3.	Higher	7.7
4.	Total	9.4

(1) Approximate figure taken for the M.R.P. Report.

Source: Instituto Nacional de Estatística (Estatística da Educação, 1964-65)

4. At present, technical and other vocational education starts after four years of primary schooling, i.e. at the age of ten or eleven and consists of:

(i) an elementary or preparatory stage, common to all branches and lasting two years;

(ii) a second stage, which includes training courses of varying duration in industrial, commercial, agricultural and other vocational branches;

(iii) a third stage comprising the Industrial and Commercial Institutes.

Links between general and vocational courses are rather weak, the transfer of pupils from one stream to another, particularly from the vocational to the general, being rare.

5. The main school courses under the present educational system are summarised below. Technical and other vocational courses are described in detail under the appropriate headings

in the text and the appendices. Appendix I gives a simplified structure of technical and other vocational education within the framework of the educational system as a whole; Table 2 summarises the statistical data available for the school year 1964/65. Supplementary statistical data are given in Appendix VI.

(a) Nursery Schools

6. Nursery schools belong to private organisations and are concentrated mainly in large towns; they are attended by children under six years of age. Education at this stage is not compulsory.

(b) Primary Education

7. All children between seven and thirteen have to attend a primary school until they obtain their primary school leaving certificate. The course lasts four years, at present, and terminates by either the primary school leaving certificate or the entrance examination to secondary school. Children attending the first grade of the primary school in 1964/65 or in subsequent years are covered by the new Act (paragraph 1) which demands attendance from seven to fourteen years of age unless they pass the 6th primary grade examination or the corresponding examination upon completion of the preparatory secondary course.

(c) Secondary and Intermediate Education

8. The most important legislation concerning secondary education is the "statute of State Schools" and the "Statute of Trade Technical Education", published on 17th September, 1947, and 25th August, 1948, respectively.

(i) General Secondary Schools or "Liceus"

9. General secondary education covers seven years, divided into three cycles of two, three and two years respectively. There are two types of public "Liceus": the "National" which are financed by the State (in the islands of the Açores and Madeira by the respective independent administrative district) and include at least the first two and in most cases all three cycles, and the "Municipal" which are financed by the municipalities and offer only the first cycle. General secondary education absorbs nearly 50 per cent of the total secondary school population (Table 2).

10. The first two secondary cycles are intended to equip pupils with the minimum amount of knowledge required for the harmonious development of their capacities and for a basic culture; the curriculum is the same for all pupils at these

stages. The third cycle concentrates on preparing the pupils for higher education, the programme at this stage being divided into separate sections, each designed to offer specialised knowledge.

11. To qualify for admission to the first year of Liceus pupils must have reached the age of ten (before 31st December of the year in which they enter the Liceus) and pass an entrance examination. At the end of each cycle, written and oral examinations entitle successful candidates to the general secondary education certificate (completion of the second cycle) or to admission to a higher education establishment (completion of third cycle). The written examination papers are normally set by teachers under the supervision of general secondary school inspectors and are the same throughout the country. Third-cycle examinations also include practical tests in physics, chemistry and natural science. Pupils who pass the examinations at the end of the first and second cycles may transfer to some other stream.

(ii) Technical and other vocational schools

12. Technical and other vocational education is provided by: Industrial Schools and Institutes; Commercial Schools and Institutes; Training Schools for Farm Managers, Practical Agricultural Schools; Agriculture Vocational Schools; and several other types of vocational schools, e.g. for social workers, nurses and midwives, etc. Technical and vocational education is, at present, preceded by a two-year preparatory cycle to which pupils are admitted on the completion of primary schooling and after passing an examination. This cycle, which is common to industrial, commercial and agricultural education, is primarily a period for observation and orientation intended to bring to light any special abilities and aptitudes.

(1) Industrial Schools and Institutes

The Industrial Schools (Escolas industriais) provide three or four-year courses in several trades. Young people may enter these schools after completing the preparatory vocational cycle. Graduates of the Industrial Schools may follow a further specialised course lasting one or two years, according to the trade, plus six months of practical work. In some Industrial Schools there are special courses available, preparatory for entering the Industrial Institutes. These courses usually last two years and are attended after completion of the training course. However, in cases when students reach a certain level in the final examinations of the training course the total period of study for access to the Industrial Institutes may be shortened to one year.

The Industrial Institutes (Institutos industriais) are open to candidates who have attained the age of 15 and have passed an entrance examination - this differs according to the educational background of the candidate (paragraph 38). Courses at the Industrial Institutes last four years and are followed by a practical training period of at least six months. Graduates of the Industrial Institutes are awarded the title of "Engineering Advisor". The law also provides that "it is the mission of the Industrial Institutes to train auxiliary engineering staff and industrial technicians". Upon completion of the second year of their studies, students of the Industrial Institutes may enter a Higher Engineering School. Industrial Institutes are considered as Intermediate level schools.

(2) Commercial Schools and Institutes

The Commercial Schools (Escolas comerciais) correspond to the Industrial Schools and are organised along a similar line. The actual courses last three years and are followed by a period of practical work which, in general, is optional.

The Commercial Institutes (Institutos comerciais) provide training for administration assistants, accountants, etc. The standard is equivalent to that attained by the Industrial Institutes (intermediate level). Courses at the Commercial Institutes last three years.

(3) Agricultural Schools and courses

The Practical Agricultural Schools (Escolas práticas de agricultura) provide training for skilled workers in agriculture and are open to pupils who have completed two years of general or preparatory vocational secondary education. The actual course lasts two years and is concluded by six months practical work.

The Farm Management Training Schools run five-year courses; admission is by examination in French, and candidates must have completed two years of secondary education (general or preparatory vocational). The course is followed by a period of at least six months' practical training.

(4) Other vocational schools

Vocational education also includes courses for social work, nursing and midwifery. Courses for "social assistants" last two years followed by a six months practical stage while courses for nurses last three years. Both are open only to holders of the general secondary school certificate (5 years of secondary schooling). Midwifery courses last one year and are open to nurses only. The minimum age of admission to any of the above courses is 18 years.

(iii) Teacher Training

13. Training for primary school teachers is provided in Teacher-Training Schools (Escolas de magistério primario); it lasts two years including six months' teaching practice and candidates must have completed the second stage (5 years) of Liceu. Training courses for nursery school teachers also last two years but candidates may be admitted after completing only the first stage of a Liceu. Teachers in General Secondary and Technical Schools are required to pass the "educational science course" offered by the Faculties of Arts (one year) and have two years of professional teaching practice.

(d) Higher Education

14. Higher Education is provided by four Universities and a number of Public and Private Colleges. Courses at this level last from three to six years, depending on the branch, and are sometimes followed by practical training which may last one year. Candidates must normally pass an entrance examination after completing the third stage of a General Secondary School or the second year of an Industrial or Commercial Institute, or the complementary course of a Farm Management Training School.

Table 2

Summary of statistical data on education

(1964-65)

Type and level of education	No. of establishments	Pupils		Teachers	
		Number	% of total school population	Number	Teacher/pupil ratio
1. Primary	17,915	894,195	73.0	27,735	1:32.2
2. Secondary and Intermediate	860	298,527	24.4	14,590	1:20.5
(i) General (liceus)	424	144,657		6,965	1:20.8
(ii) Technical and other vocational(1)	436	153,870		7,625	1:20.2
Commercial and industrial schools	(166)	(140,329)		(6,495)	
Commercial and industrial institutes	(6)	(5,008)		(264)	
Agricultural schools and courses(2)	(235)	(5,274)		(356)	
Other vocational schools and courses(3)	(29)	(3,259)		(510)	
3. Higher	73	31,575	2.6	1,917	1:16.5
(i) Engineering	2	2,488(4)		125	
(ii) Agriculture	2	651		69	
(iii) Other	69	28,436		1,723	

(1) Excluding teacher-training, artistic and adult education.
(2) Including courses for agricultural apprenticeship.
(3) Social worker, nursing and midwifery courses.
(4) Excluding students attending preparatory courses in the science faculties of Lisbon, Oporto and Coimbra.

Source: Instituto National de Estatística (Estatística da Educação, 1964/65)

II. EDUCATIONAL AND VOCATIONAL ORIENTATION AND GUIDANCE

15. Educational and vocational orientation and guidance are not organised as a regular school service. Activities in this field are initiated by the "Institute of Professional Orientation" in Lisbon which is under the jurisdiction of the Ministry of Education. The Institute holds a considerable number of psychological tests and examinations each year, the majority of which are aptitude tests requested by the Civil Service - and sometimes by private firms - for their candidate employees. Medical service is also available.

16. The Institute of Professional Orientation has little formal contact with schools which seek its advice in special cases only. Each year, and on their own initiative, about two thousand primary and secondary school graduates take aptitude tests or seek vocational orientation advice.

17. Practical subjects to provide pupils with an introduction to technical or other kind of vocational education are completely eliminated from general secondary schools, but in preparatory vocational courses 12 to 14 instruction periods per week are devoted to these subjects, as shown in Table 3.

Table 3

Vocational Preparatory Cycle - Programme time-table

Subjects	Instruction periods per week		
	Years 1	2	Total (units)(1)
a. General subjects	17	16	33
History and languages	5	5	10
Natural sciences and geography	4	4	8
Religion	2	1	3
Mathematics	3	3	6
Music	1	1	2
Physical training	2	2	4
b. Technical subjects	12	14	26
Drawing	6	8	14
Manual work	6	6	12
Totals	29	30	59

(1) One unit corresponds to approximately 40 instruction periods.

III. AUTHORITIES IN CHARGE OF EDUCATION - CO-ORDINATING AND PLANNING MECHANISMS

(a) Ministry of Education - National Education Board

18. The control of education is the responsibility of the Ministry of National Education apart from some special short courses in agriculture under the Ministry of Economic Affairs, the military training, under the Ministries of the Army and the Navy, and certain institutions under the Ministry of Corporations and Social Welfare.

19. Within the Ministry of Education there is a General Directorate of Vocational Education covering technical, commercial, agricultural and other types of vocational education. The National Education Board (Junta nacional de educação), which is a technical advisory body attached to the Ministry of Education, is divided into several specialised sections, one of which deals with vocational education matters such as: structure and content of curricula, evaluation and choice of text books, equivalence between foreign and local diplomas and certificates, etc. This section includes representatives from education, industry and commerce.

20. The major part of the educational expenditure is borne by the State. The public education budget is drawn up by the Minister of Education, sanctioned by the Finance Minister and approved by the Cabinet. Primary education is free; a nominal fee is charged at the higher levels. The State provides assistance for pupils in secondary schools and for students in Intermediate Schools and Universities, in the form of scholarships and exemption from fees.

(b) Office of Educational Research and Planning

21. In 1965, the Government set up an Office of Educational Research and Planning, the GEPAE (Gabinete de Estudos e Planeamento da Acçao Educativa) under the Ministry of Education. The GEPAE, whose creation may be regarded as a direct consequence of the first phase of the M.R.P.(1), is mainly concerned with keeping the qualitative and quantitative aspects of educational development under continuous review in the light of economic and social trends. It is also responsible for providing public or private agencies with information on educational matters.

22. The GEPAE was set up at the time when the preparatory work had begun for the Third National Development Plan (1968-73) and was therefore charged with the preparation of that part of the plan concerned with education and research.

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(1) Mediterranean Regional Project (O.E.C.D.)

23. Work in 1965 and 1966 was mainly concerned with deciding the educational development objectives for the 1968-1973 period, and the resources to be set aside for them. Efforts were generally concentrated on the following points:

(i) anticipated school population in the period 1968-73;

(ii) number of buildings and teachers required to meet the needs of this population;

(iii) financial consequences of the objectives chosen;

(iv) regionalisation of overall objectives;

(v) analysis of the demand for skilled labour.

Once the preparatory work has been carried out, the appropriate authorities and agencies are planning to launch a series of supporting studies to ensure the effective implementation of the Third Development Plan in the educational field.

Part Two

TRAINING OF TECHNICIANS AND OTHER TECHNICAL MANPOWER

IV. DEFINITION AND GRADING OF TECHNICIANS - STANDARDISED QUALIFICATIONS

24. In Portugal, graduates of the Industrial Institutes who, according to the classification adopted by O.E.C.D., correspond to upper-level technicians, are awarded the professional title "Engineering Advisor" (Agente técnico de engenharia).

25. Lower level technicians are trained mainly in the industrial and other vocational schools, together with craftsmen. There is no special term adopted to define this category of skilled personnel.

26. The central administration and control exercised by the Ministry of National Education has led to uniformity throughout the country in the structure and content of the various courses within the educational system.

27. Syllabuses are prepared by the Ministry in consultation with the specialised sector of the National Education Board (paragraph 19). Private industrial or other vocational schools have to follow the official programmes if they wish to be recognised by the State. Final examinations are set by the schools but are controlled and supervised by the Ministry of National Education. Certificates and diplomas are issued by the training institutions and are endorsed by the Ministry.

V. LOWER-LEVEL TECHNICIAN COURSES WITHIN THE EDUCATIONAL SYSTEM

28. At present, vocational education begins after four years of primary schooling, at the age of ten or eleven. It starts with a common preparatory two-year cycle (ciclo preparatorio) which leads to industrial, commercial, agricultural or other vocational training.

29. Industrial courses are held by the Industrial Schools which are three to four-year institutions for pupils wishing to learn a trade. In 1964/65 there were over 150 such schools scattered throughout the country, the majority of them being combined with commercial schools of the same level.

30. At present there are courses available in:

General metal work; precision mechanics; sheet-metal work; foundry; electrical fitting; electro-mechanics; radio fitting; carpentry and cabinet making; wood-carving; mould-making; civil construction and mining; chemical laboratory techniques; pharmaceutical techniques; industrial and laboratory chemistry; textile mechanics; spinning; decorative painting; decorative sculpture; decorative ceramics; artistic furniture making; graphic arts (photography-engraving-printing-lithography); book-binding; optic instruments; home-economics; sewing and embroidery; watch-making; jewellery; paper making techniques; ceramics.

Most Industrial Schools offer special courses for further specialisation within the above fields (paragraph 34). The number of basic and special courses available is given, together with examples of programme time-tables, in Appendix II.

31. Admission to Industrial Schools is granted to those completing the two-year preparatory vocational cycle, offered by the same Industrial Schools or, in a few cases, by separate "Elementary Vocational Schools". On completing the training course pupils may specialise further by attending one or two-year courses, followed by at least six months' practical work in the trade concerned. Those who successfully complete this extension course, including the practical work required, are eligible to take the examinations for the "Trade Proficiency Certificate".

32. It is difficult to differentiate sharply between craftsman and technician courses offered by the Industrial Schools. Although entrance requirements are identical, some courses include technological subjects and laboratory work at a sufficiently high level to justify their being classed as

technician courses. Such courses are for radio-electrical installations, chemical laboratory assistants, and textile technicians. In craftsman courses emphasis is on workshop practice and the level in technology is generally lower than that in technician courses.

33. A percentage breakdown of the time allocated to each group of subjects in craftsman and technician courses is given in Table 4. Further details concerning curricula and timetables may be found in Appendix II.

34. Full-time specialisation courses (paragraph 31) have a structure similar to that of the corresponding basic courses; however, general subjects are excluded during this period and more emphasis is given to practical work. Table 5 shows the specialisation courses so far available.

35. Of the above courses only three (dressmaking; under-wear; needlework) last two years; the rest are one-year courses following the corresponding basic course. Again, the distinction between craftsman and technician courses cannot be sharp in all cases; courses specialising in drawing and the biology laboratory assistant course, however, may be positively classed as technician courses.

36. Students who have successfully completed the second year of an industrial school course may follow a special two-year preparatory course for entrance to the Industrial Institutes (upper level technician courses). This course is mainly theoretical with emphasis on foreign languages, technical drawing and science, and differs slightly according to the nature of the basic course followed. Some examples are given in Appendix II. Applicants for admission to this course must have obtained in the second year an average mark of at least 12 out of 20 in the subjects regarded as essential for the career they have chosen. Students who do not reach this level in the second year can only be admitted to the preparatory course after completion of the training course in the Industrial Schools.

Table 4

Structure of courses in Industrial Schools

(percentage of time devoted to each group of subjects)

Group of subjects	Lower technician courses			Craftsman Courses	
	Radio fitting	Chemical lab. asst.	Textile technician	General metal	Carpentry/ cabinet making
1. General subjects	12.5	25.5	13.5	10.5	11.5
2. Maths, science and technology (inc. labor. work)	56.0	74.5	49.0	40.5	32.5
3. Workshop practice	31.5	-	37.5	49.0	56.0
Totals	100.0	100.0	100.0	100.0	100.0

Table 5

Specialisation courses (1964)

Basic course	Corresponding specialisation courses
1. General metal	Turning and cutting; fitting; machine-shop; auto-mechanics; aviation mechanics; industrial drawing; naval construction drawing; agricultural mechanics.
2. Carpentry/cabinet-making	Civil construction drawing
3. Chemical laboratory assistant	Biological laboratory assistant
4. Home economics	Dress-making; under-wear; millinery
5. Embroidery	Needle work; embroidery design
6. General commerce or any industrial course	Specialised course for settlers

VI. UPPER-LEVEL TECHNICIAN COURSES

37. Upper-level technician courses are held by the Industrial Institutes which are four-year institutions specialising in industrial subjects. At present, there are three such establishments in Lisbon, Oporto and Coimbra. The "Army Cadets' Technical Military Institute" may also be considered as an intermediate level educational establishment for commercial and industrial training. The Industrial Institute in Lisbon was first established in 1911 as a secondary technical school, its graduates receiving the title of "Condutor". In 1919, admission requirements were raised to a secondary (second cycle) school certificate and the programme included 35 different subjects plus foreign languages and laboratory and workshop practice. At a later stage (1924) the title of the graduates was changed to "Assistant Engineer" and, in 1926, to "Engineering Advisor" (agente técnico de engenharia) which still holds. The syllabuses and the educational and administrative arrangements are regulated by two Decrees (November 1950).

38. The following are eligible for admission to the Industrial Institutes after passing an entrance examination:

(i) graduates of the second cycle of general secondary schools or those who have completed the preparatory section of an Industrial School (paragraph 36). Examinations are both written and oral, and include mathematics, physics, chemistry and drawing; candidates who have attained 14 marks out of 20 in the preparatory course are exempt;

(ii) those who have completed the second year of a General Secondary School (first cycle) or the Preparatory Vocational Cycle and any vocational course. Examinations in this case include Portuguese, French or English, geography and history, natural sciences, mathematics, physics, chemistry and drawing. Examples of entrance examinations are given in Appendix III.

It is estimated that, of the students now attending Industrial Institutes, only 30 per cent have completed the Second General Cycle, the rest coming from Industrial Schools. The minimum age for admission is fifteen.

39. The following three specialisations are now available at the Industrial Institutes:

(i) civil engineering and mining;

(ii) electrical and mechanical engineering;

(iii) chemistry and chemical engineering.

Training programmes include science and mathematics, technological disciplines and laboratory and workshop practice as shown in the programme time-tables below (Tables 6, 7 and 8). An outline of the content of some of the disciplines is given in Appendix III.

40. Practical training during the course is carried out in the laboratories and workshops of the institutes. On the completion of the course proper or at least the third year, students are required to undertake practical work in State or private enterprises for a total of 180 working days, namely 90 in each of the two main fields of specialisation included in each course (paragraph 39).

41. At the end of the practical work period students must present to their school authorities their employer's report on their performance. If the report is satisfactory students are entitled to take part in the "Professional Ability Examinations", which are held by a school committee consisting of three teachers and are related to the practical work performed. Successful candidates are awarded the "Certificate of Professional Ability" and the title of "Engineering Advisor" (agente técnico de engenharia). The final pass mark stated in the certificate is an average of the marks for each year and that obtained at the Professional Ability Examination, multiplied by the coefficients 1, 2, 3, 3 and 3 respectively.

42. "Wastage" from upper-level technician courses appears to be a major problem for Portugal. It is estimated that only one-third of those entering the Industrial Institutes complete the course within reasonable time limits. The main reasons for this high rate of "drop out" are:

(i) some students enrol in the institutes with the sole purpose of improving their position in industry as some public and private enterprises offer better conditions to holders of admission examination certificates to industrial institutes;

(ii) a number of students give up their studies to seek employment for financial reasons; school fees amount to more than esc. 500(1) per year;

(iii) many use the Industrial Institues as a stepping stone to university studies; at the completion of the second year, students may apply to sit for an entrance examination to the university if they have attained a certain standard specified by the regulations. It is estimated that about

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(1) One U.S. dollar = 30 escudos.

15 to 20 per cent of the students completing the second grade of an industrial institute continue their studies at the university;

(iv) many students during the practical final stage of their studies (paragraph 40) find themselves placed in interesting and rewarding posts in industry; therefore they never bother to take the final examinations for the certificate of professional ability;

(v) some are obliged to discontinue their studies to do their military service which starts at the age of 20 and lasts for 3 or 3½ years.

Table 6

Civil Engineering and Mining

Subjects	Instruction Periods per Week											
	1st year			2nd year			3rd year			4th year		
	A	B	C(1)	A	B	C	A	B	C	A	B	C
Algebra, geometry, trigonometry	3	4	–	3	4	–	–	–	–	–	–	–
Calculus, descriptive geometry	–	4	–	–	–	–	–	–	–	–	–	–
General physics	3	–	4	–	–	–	–	–	–	–	–	–
Special physics	–	–	–	3	–	4	–	–	–	–	–	–
General chemistry	3	–	4	–	–	–	–	–	–	–	–	–
Mineralogy and geology	3	–	2	3	–	2	–	–	–	–	–	–
Mechanics and strength of materials	–	–	–	2	2	–	2	3	–	–	–	–
Topography	–	–	–	3	4	–	–	–	–	–	–	–
Buildings	–	–	–	–	–	–	3	4	–	–	–	–
Reinforced concrete materials and construction	–	–	–	–	–	–	3	4	–	3	4	–
Stability of structures, bridges	–	–	–	–	–	–	–	–	–	3	4	–
Highways and railways	–	–	–	–	–	–	2	2	–	3	4	–
General and applied hydraulics	–	–	–	–	–	–	3	4	–	3	4	–
Mining prospection and exploration	–	–	–	–	–	–	3	3	–	3	3	–
Minerometallurgical technology	–	–	–	–	–	–	–	–	–	3	–	–
Mineral analysis	–	–	–	–	–	–	–	–	–	–	–	3
Electrotechnics and machine elements	–	–	–	–	–	–	2	1	–	–	–	–
Heating and ventilation	–	–	–	–	–	–	1	–	–	–	–	–
Constructional drawing	–	4	–	–	6	–	–	–	–	–	–	–
Carpentry and practical work on construction sites	–	–	8	–	–	6	–	–	4	–	–	–
Job accountancy	–	–	–	–	–	–	–	–	–	2	–	–
Political organisation of the country and corporative(2) economics	1	–	–	1	–	–	–	–	–	–	–	–
Total	13	12	18	15	16	12	19	20	4	20	19	3
		43			43			43			42	

(1) A = theoretical instruction; B = practical instruction and graphical exercises; C = laboratory and/or workshop practice

(2) Trade Union economics.

Table 7

Electrical and Mechanical Engineering

Subjects	Instruction Periods per Week											
	1st year			2nd year			3rd year			4th year		
	A	B	C(1)	A	B	C	A	B	C	A	B	C
Mathematics (algebra geometry, trigonometry, calculus)	3	4	–	3	4	–	–	–	–	–	–	–
General physics	3	–	4	–	–	–	–	–	–	–	–	–
Special physics	–	–	–	3	–	4	–	–	–	–	–	–
General chemistry	3	–	4	–	–	–	–	–	–	–	–	–
Descriptive geometry	–	4	–	–	–	–	–	–	–	–	–	–
Topography	–	–	–	–	3(2)	–	–	–	–	–	–	–
Applied mechanics	–	–	–	3	3	–	3	3	–	–	–	–
Electricity	–	–	–	–	–	–	3	4	–	–	–	–
Electrical installations	–	–	–	–	–	–	–	–	–	3	4	–
Machine elements	–	–	–	–	–	–	2	4	–	–	–	–
Machines	–	–	–	–	–	–	3	4	–	3	4	4
Electric machines	–	–	–	–	–	–	–	–	–	3	4	6
Measurements and tests of electric machines	–	–	–	–	–	–	1	–	6	1	–	–
Technology and machine tools	2	–	–	3	–	–	–	–	–	–	–	–
Weak currents	–	–	–	–	–	–	–	–	–	2	–	4
Illumination techniques	–	–	–	–	–	–	–	–	–	1	–	–
Heating and ventilation	–	–	–	–	–	–	1	–	–	–	–	–
Mechanical drawing	–	4	–	–	6	–	–	–	–	–	–	–
Carpentry	–	–	4	–	–	–	–	–	–	–	–	–
Pattern-making	–	–	–	–	–	4	–	–	–	–	–	–
Fitting and forging	–	–	6	–	–	6	–	–	–	–	–	–
Foundry	–	–	–	–	–	–	–	–	8	–	–	–
Industrial organisation	–	–	–	–	–	–	–	–	–	2	–	–
Political organisation of the country and corporative economics	1	–	–	1	–	–	–	–	–	–	–	–
Total	12	12	18	13	16	14	13	15	14	15	12	14
	42			43			42			41		

(1) A - theoretical instruction. B - practical instruction and graphical exercises. C - laboratory and/or workshop practice.

(2) Theoretical subject during the first semester and practical during the second semester.

Table 8
Chemistry and Chemical Engineering

Subjects	Instruction Periods per Week											
	1st year			2nd year			3rd year			4th year		
	A	B	C(1)	A	B	C	A	B	C	A	B	C
Mathematics (algebra, geometry, trigonometry, calculus)	3	4	-	3	4	-	-	-	-	-	-	-
General physics	3	-	4	-	-	-	-	-	-	-	-	-
Special physics	-	-	-	3	-	4	-	-	-	-	-	-
General chemistry	3	-	4	-	-	-	-	-	-	-	-	-
Descriptive geometry	-	4	-	-	-	-	-	-	-	-	-	-
Inorganic chemistry	-	-	-	3	-	-	-	-	-	-	-	-
Organic chemistry	-	-	-	3	-	6	-	-	-	-	-	-
Analytical chemistry	-	-	-	3	-	6	3	-	12	-	-	-
Physical chemistry - electrochemistry	-	-	-	-	-	-	3	-	4	-	-	6
Chemical technology	-	-	-	-	-	-	3	-	4	3	4	8
Biological and calorimetric analysis	-	-	-	-	-	-	-	-	6	-	-	6
Mineralogy and geology	3	-	2	-	-	-	-	-	-	-	-	-
Mineronetallurgical technology	-	-	-	-	-	-	-	-	-	3	-	-
Applied mechanics	-	-	-	-	-	-	3	3	-	-	-	-
Elements of machines	-	-	-	-	-	-	-	-	-	2	4	-
Electrotechnics and elements of electrical machines	-	-	-	-	-	-	2	-	-	-	-	-
Mechanical drawing	-	4	-	-	6	-	-	-	-	-	-	-
Fitting workshop	-	-	6	-	-	-	-	-	-	-	-	-
Industrial organisation	-	-	-	-	-	-	-	-	-	2	-	-
Political organisation of the country and corporative economics	1	-	-	1	-	-	-	-	-	-	-	-
Total	13	12	16	16	10	16	14	3	26	10	8	20
	41			42			43			38		

(1) A - theoretical instruction. B - practical instruction and graphical exercises. C - workshop and/or laboratory practice.

VII. VOCATIONAL COURSES AT CRAFTSMAN LEVEL WITHIN THE EDUCATIONAL SYSTEM

43. Industrial courses at craftsman level are held by the Industrial Schools together with lower technician courses. As stated in paragraph 32 a sharp differentiation between the two types of courses is not possible. Other forms of vocational training at craftsman level are apprenticeship, "aperfeiçoamento" and "mestrança" which are mostly part-time courses complementary to practical training within industry (paragraphs 72-76).

44. The admission requirement for full-time industrial courses is successful completion of the two-year preparatory vocational cycle. The courses last three or four years, depending on the trade. Specialisations available at Industrial Schools are given in paragraph 30. The training programmes include:

(i) 20-32 per cent of general subjects such as mother language, mathematics, science, religion, civics, accounting, physical training;

(ii) 25-30 per cent of technical drawing and technology of the trade;

(iii) about 50 per cent of workshop practice.

Examples of the programme time-tables are given in Appendix II.

45. There are also "extension" courses available as shown in Table 5. The content of these courses is purely technical, over 50 per cent of the time being devoted to workshop practice (Appendix II). Students completing extension courses may, after a minimum of six months practical work in industry, sit for the "Trade Proficiency Examinations" for the corresponding certificate.

VIII. TECHNICAL TRAINING AT UNIVERSITY LEVEL

46. Higher education in Portugal is provided by the State universities and other specialised institutions both public and private. There are four State universities, one in Coimbra, two in Lisbon and one in Oporto. The first Portuguese university was founded in Lisbon in 1290. The other specialised institutions of higher education include:

(i) the following public institutions: the schools of fine arts in Lisbon and Oporto, the National Institute of Physical Education in Lisbon, the Military Academy of Lisbon, the Naval Academy in Alfeite and the National School of Public Health and Tropical Medicine in Lisbon;

(ii) the following private institutions: The Social Service Institutes in Lisbon, Coimbra and Oporto, the Higher Institute of Languages and Administration in Lisbon, the Economic and Social Institute of Evora, and the Catholic College of Philosophy in Braga.

47. Technical education at university level is provided by the universities of Lisbon and Oporto. In 1910, the existing Institutes of Industry and Commerce in Lisbon and Oporto were divided into separate schools of Advanced Engineering and Advanced Economic Studies, and became the Higher Technical Institute and the Institute of Economic and Financial Studies in Lisbon and the Faculty of Engineering and Economics in Oporto. In 1930 the Technical University of Lisbon was founded, incorporating the establishments of higher technical education operating in the city at that time. The Technical University of Lisbon comprises at present: The Higher School of Veterinary Medicine; the Higher Institute of Agronomy; the Higher Institute of Economic and Financial Sciences; the Higher Institute of Social Science and Overseas Political Studies and the Higher Institute of Technology (Instituto superior técnico).

48. The universities are autonomous bodies so far as administration, allocation of time, and academic affairs are concerned and are represented on the National Board of Education through their rectors and a member of the academic staff of each type of faculty or school. The Ministry of Education is responsible for all public institutions of higher education with the exception of those specialised institutions coming under other Ministries. The financial resources of the universities are: annual allocations from the budget of the Ministry of education, subsidies and donations offered by the State or public and private bodies, and profits from their property.

49. Admission to the technical faculties is granted to applicants who have passed the final examination of the third cycle of a General Secondary School (Liceu) in the science line and the entrance examinations to the faculty, and to those who have completed successfully the second year of studies in an Industrial or Commercial Institute or the complementary course of a Farm Management Training School and have succeeded at the entrance examinations of the faculty. Candidates with a "good" or "above average" rating in their entrance credentials and in two of the subjects considered as "basic" for entering the faculty are exempt from entrance examinations.

50. The length of university studies varies with the faculty; for engineering and medicine, for instance, it is six years (plus a period of professional practice) while for science and other faculties it is five. Students of the engineering faculties undergo, upon completion of their studies, a period of practical training in industry for four months. During this period they must submit to the faculty reports related to the subject matter of their training. Candidates for a doctorate must have obtained a minimum of sixteen points in the "licenciatura" (first degree) and pass the doctoral examinations.

51. At present, the following specialisations are available in the Technical University of Lisbon and the Faculty of Engineering in Oporto: mechanical engineering; electrical engineering; chemical engineering; civil engineering; mining. Enrolment for the academic year 1964/65 was 350 (Table 9), which is hardly more than one per cent of the total enrolment in higher education (31,575). Architecture was 426.

Table 9

Enrolment in engineering faculties (1964-65)

Mechanical engineering	70
Electrical engineering	78
Chemical engineering	86
Civil engineering	113
Mining	3
	350

IX. TECHNICAL TEACHING STAFF

(a) Teachers at Industrial and Commercial Schools

52. Vocational school teachers are classified as "efectivos, adjuntos, auxiliares, contratados do quadro, extraordinários" and "de serviço eventual" or "provisórios".

53. The "efectivos" and the "adjuntos" form part of the permanent teaching staff and must hold a higher education diploma or degree, have completed the educational science course of the Faculties of Arts, including the two-year teaching practice (paragraph 65) and have passed the final state-examination for teachers.

54. Auxiliary teachers (auxiliares) also form part of the permanent staff. They must possess an intermediate-level diploma or that of a special two-year university course for auxiliary teachers as well as theoretical and practical pedagogical training and have passed a state examination similar to that for the "efectivos" and "adjuntos". Primary school teachers who have completed their course with an average of at least fifteen marks out of twenty and who have a minimum of ten years satisfactory service may be admitted to the university course for auxiliary teachers.

55. Of the other teaching staff categories, the provisional teachers (provisórios) are appointed year by year and, in principle, they possess qualifications corresponding to those of the permanent teaching staff. The "contratados do quadro" teach physical training and music. The category of "extraordinários" has been created recently to meet unforeseen requirements and are paid according to the same scales as the "provisórios". Apart from the above categories the Industrial and Commercial Schools employ instructors who teach the practical subjects; these may be employed on either a permanent or temporary basis as "mestres", "contramestres" and "auxiliares de ensina". Instructors are recruited through a competition open to holders of an industrial or commercial school diploma.

56. Between 1950 and 1960 the increase in teachers in Industrial and Commercial Schools was among the highest in the educational system; this was a direct result of the increase in enrolment. In 1964/65 the total number of teachers in these schools was 6,495 of which 6,150 were in State schools (4,703 teachers and 1,447 instructors).

57. A survey of technical schools in 1960/61(1) showed that the provisórios far outnumber the other categories and that very few of the existing teachers are fully trained, the main

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(1) This survey extended to 92 schools, of which 81 replied. (The Mediterranean Regional Project: Portugal, O.E.C.D. Paris, 1966).

reason for this being the very low level of salaries as compared with the qualifications required; furthermore, the legal quota of teachers is far from adequate to meet current needs. The teacher/pupil ratio rose between 1958/59 and 1964/65 (1 : 20.2 in 1965) indicating that too few teachers were recruited as compared with the fast growing enrolment.

58. The survey also showed that of the 81 head-masters who replied, only three were satisfied with the quality of their staff, one was satisfied with the number of teachers but not with their breakdown by category, while the other 77 found their staff either insufficiently or unsuitably qualified. A breakdown of teachers in State Industrial and Commercial Schools by qualifications is given in Table 10.

Table 10

Breakdown of teachers in State Industrial and Commercial Schools (1961-62)

Qualifications	Percentages
Degree	51.2
Adjunto diploma	1.3
Higher education, not completed	2.3
Students still in higher education	4.0
Intermediate (post-secondary) education	8.1
Teacher-training school (primary)	1.2
Religion or Military Instruction	3.9
Other	28.0
	100.0

Source: School Survey, C.E.M.E., 1962/M.R.P.

59. The legal number of teaching hours in technical schools is much the same as in "Liceus"; it varies from 18 to 24 per week depending on the category and the years of service of the teacher. Mestres and contramestres, however, have to work longer hours, while other members of the staff have shorter hours because of other duties such as those of the head of department, etc. The 1962 survey showed that 15.4 per cent of the teachers in industrial and commercial schools were overworked, 51.5 per cent had a full-time programme, the remaining 33.1 per cent being employed as part-time staff.

60. Past details concerning the staff of private Industrial and Commercial Schools are either scarce or completely lacking. The number of these private school teachers, however, is so small (345 in 1964) that it does not really affect what has been said. The 1962 survey showed that 53.5 per cent of the teachers in private Industrial and Commercial Schools were university or other higher education institution graduates.

(b) Teachers in Other Vocational Schools

61. Teachers in agricultural schools are very few because:

(i) the agricultural apprenticeship courses which are the main activity of these schools have few official teaching staff. In 1960-61 for instance, 118 such courses were given by 126 teachers who were primary school teachers, priests, or other people with practical experience;

(ii) few pupils attend agricultural courses and the rate of increase is very low.

Official teachers possess the required qualifications; 62.2 per cent work part-time as against 32.4 per cent working full-time and 5.4 per cent overworked.

62. Teachers in schools for nurses and welfare workers do not usually consider teaching as their main job. In 1961-62, for instance, the average weekly number of teaching hours per teacher was 9 in schools for nurses and 3.6 in schools for welfare workers. Furthermore, the pupil/teacher ratios are very low, namely 7.6 in the nursing schools and 2.7 in the schools for welfare workers, which means that the system is not functioning efficiently.

(c) Teachers at Industrial and Commercial Institutes

63. Teachers at Industrial and Commercial Institutes are few (264 in 1964) because of the low enrolment. Practically all of them have a university degree or equivalent qualification. The 1962 survey, however, showed that 3.8 per cent were not really qualified in the subjects they taught. Very few have pedagogical training. Teaching hours for the permanent full-time staff (ordinarios) are considerably fewer than in secondary schools, that is only 12 hours per week, reduced to 9 after 20 years of service. Auxiliares teach from 18 to 22 hours per week.

64. Salaries of teachers at Industrial Institutes are considerably lower than of those with equivalent qualifications working in industry. "Ordinarios", for instance, have a starting basic monthly salary of approximately esc. 4,500 (plus

20 per cent cost of living allowance), as compared with at least 6,500 they can earn in industry. After ten years of service, salary increases by some esc. 900 and after twenty years by about esc. 1,100. "Auxiliares" have still lower rates. All teachers, however, have supplementary jobs in industry, thus earning additional emoluments.

(d) Teacher-training Courses

65. The Faculty of Arts and Humanities of the University of Lisbon holds a special short course for teachers in industrial and other vocational schools, followed by two years teaching practice. Although there are few fully qualified teachers, the number admitted each year to this training course is limited by ministerial order and the proportion of passes in the entrance examinations is relatively low. The number of those applying for admission to the course is also low as a result of the small salaries offered. Posts, therefore, remain vacant even though there are too few to meet requirements.

X. TRAINING OUTSIDE THE EDUCATIONAL SYSTEM

(a) Apprenticeship

66. Apprenticeship in Portugal is still somewhat restricted, the number of apprentices receiving training being less than 3,000 (2,200 in 1963). Apprenticeship is controlled by the Ministry of Education, but the Ministry of the Corporations and Social Welfare has recently launched a training scheme for industrial workers who have had no previous formal training. Over 100,000 persons are now being trained under the new scheme. Activities in the apprenticeship type of training have also been initiated by the "Manpower Development Fund" (paragraph 80).

67. Apprenticeship under the auspices of the Ministry of Education has a duration of three or four years, depending on the trade, and covers the trades listed in Table 11.

68. The training programme includes practical work in enterprises and is completed by a theoretical course (complementary apprenticeship course) provided by industrial or other vocational schools. The total number of instruction periods per week does not exceed thirteen although allowance has been made for nineteen. Employers release their apprentices two hours a day to attend the school.

69. The complementary course includes general subjects, technology of the trade and other relevant subjects, as well as some workshop practice as shown in Table 12.

70. Apprenticeship training courses are open to holders of a primary-school leaving certificate, or equivalent, provided they are at least 13 years of age. The Minister of Education, however, after consultation with the General Directorate of Vocational Education, may raise the entrance requirements for some courses to the vocational preparatory-cycle certificate.

71. Apprentices who successfully complete both the practical training and the complementary course are eligible to take the examinations for the "Trade Proficiency Certificate". These examinations are organised by the schools under rules and regulations established by the Ministry of Education and are open to graduates of Industrial Schools as well (paragraph 31).

(b) "Mastership" Courses (cursos de mestrança)

72. "Mestrança" courses are intended to equip skilled workers with both the general and technical knowledge required for them to perform as journeymen (mestras and contramestras) or to be in charge of industrial workshops. "Mestrança" courses are held by the Industrial Schools and are either part-time evening (civil construction, topography, milling) or full-time day courses (canning, mining). Part-time courses last four years (14 to 16 instruction periods per week); full-time courses last two years.

Table 11
Apprenticeship courses available

Trade	Duration	Trade	Duration
1. General metal work	4 years	11. Book-binding	4 years
2. Electrotechnics	4 "	12. Weaving	4 "
3. Carpentry-cabinet making	4 "	13. Textile mechanics	4 "
4. Wood carving	4 "	14. Textile industry (general)	4 "
5. Glass making	4 "	15. Dyeing	4 "
6. Plastering	4 "	16. Jewelry	3 "
7. Ceramics	4 "	17. Oil industry	3 "
8. Chisel-work	4 "	18. Stonework	3 "
9. Printing (Composition)	4 "	19. Commerce	4 "
10. Printing (press work)	4 "		

Table 12
Programme time-table of an apprenticeship course in General metalwork

	Instruction periods per week			
	1st year	2nd year	3rd year	4th year
Language and history	2	2	2	-
Religion	1	1	-	-
Hygiene	-	-	1	-
Trade Unionism(1)	-	-	-	1
Budgeting and costing	-	-	-	1
Mathematics	3	2	2	-
Elements of physics and applied mechanics	-	2	2	1
Technical drawing	4	3	2	2
Technology of the trade and workshop practice	3	3	4	8
Total	13	13	13	13

(1) Formação Corporativa

73. The programme of training includes mother tongue, scientific and mathematical disciplines, technology of the trade, drawing and other special subjects as shown in the examples included in Appendix II.

(c) Up-grading Courses

74. Up-grading courses are part-time evening courses run by industrial or other vocational schools. The length of courses varies from one to three years, depending on the trade, as shown in Table 13.

Table 13

Up-grading courses available

Field	Courses	Length
1. Metal work:	Turning; fitting, machining; automotive mechanics, welding	1 year
	Artistic metal work	3 years
2. Electricity:	Radio repairs	1 year
3. Stone work:	Artistic stone-work	3 years
4. Woodwork:	Wood carving	3 years
5. Chisel work:	Goldsmithing	2 years

75. Up-grading courses are open to graduates of primary schools with at least two years industrial experience in a trade related to the training course concerned. For certain courses previous attendance in full-time vocational courses (one to two years) is also required. Examples of the content of up-grading courses are given in Tables 14 and 15.

Table 14

Programme time-table for an upgrading course in turning (one year)

(hours per week)

Applied mechanics	2
Work techniques	2
Mechanical drawing	4
Practical work	4
Total	12

Table 15

Programme time-table for an up-grading course in artistic metal work

(Hours per week)

	1st year	2nd year	3rd year
Drawing	4	4	4
Modelling	4	4	4
Technology and Workshop	4	4	4
Total	12	12	12

76. Evening courses equivalent to full-time vocational courses (paragraph 30) are available for some trades; they normally last six years (average of 14 hours per week) and lead to the "Trade Proficiency Certificate" (paragraph 31).

(d) Activities of the Manpower Development Fund (Fundo de Desenvolvimento da Mao-de-Obra: F.D.M.O.) and of Other National Institutions

77. The Manpower Development Fund was set up in 1962 by the Ministry of the Corporations and Social Welfare. It includes, among other departments, an Institute for Accelerated Vocational Training, an Institute for Financial Co-operation for Vocational Training Activities, the National Centre for Instructor Training and the National Employment Service.

78. The Accelerated training courses last six months and cover, at present, the following skills: weighing, turning, adjusting, metal work, soldering, carpentry, masonry, concrete structures, painting, low tension electricity, automobile electricity, and electrical apparatus. Syllabuses allow for 80 per cent working practice and 20 per cent related theory.

79. The first accelerated vocational training establishment was built in Lisbon in 1964. Two more, included in the Economic Development Plan for 1965-67, are being built, at Seixal and Oporto. So far, about 400 adults have taken these courses with excellent results. Total capacity as from 1968 is reckoned at about 1,500 per annum.

80. With regard to apprenticeship training, the Manpower Development Fund is planning "common (industry and government) apprenticeship centres". This new scheme will be based on

close collaboration between industry and government and will be jointly financed. Courses will be open to candidates who have completed the primary school and are between 14 and 20 years of age. The length of the courses varies from one to two years, depending on the trade, with four or eight instruction hours a day for employed and unemployed trainees respectively. The syllabus includes a general education/guidance course followed by specialised training. The latter occupies two-thirds of the total training period and includes 50 per cent workshop practice and 50 per cent related theory and general knowledge, such as technical drawing, technology, mathematics, work organisation, legislation and safety. The instructors for the above courses will be trained at a special centre, to form part of the Fund. The Development Plan allows for 100 apprenticeship centres to be set up in the period 1965-73 to train about 10,000 apprentices a year. The relation that is to exist between the training provided in this centre and the apprenticeship scheme under the Ministry of Education has not yet been defined.

81. The Manpower Development Fund will also give its attention to the training of adults. For this purpose a team of instructors was set up in 1964 with the support of the I.L.O. This team is now at the disposition of any industrial undertaking wishing to carry out short courses (2 to 6 weeks) for employed technical staff. During the period 1964-66, 45 of these courses were completed with a total attendance of 400.

(c) Activities of Other National Institutions

82. The "National Industrial Research Institute" (Instituto Nacional de Investigação Industrial - I.N.I.I) directed its activities towards training supervisory and managing personnel for industry and the Civil Service. Courses started in 1960 and about 4,500 persons were trained by the end of 1965.

83. The "Corporation of Industry" (Corporação da Indústria), established nine years ago, is an association of "public utility" which comprises enterprises (employers and employees) from several economic sectors including commerce and agriculture. The managing authority is a council elected from among the members of the Corporation but subject to the approval of the government. This Corporation has an active interest in the development of vocational training; for example, it initiated the setting up of the Manpower Development Fund (paragraph 77). The establishment of a "Productivity Centre" in Lisbon with international assistance (I.L.O.) was also a result of such interest. One of this Centre's aims is the promotion and co-ordination of activities in the field of vocational education, with particular emphasis on apprenticeship and accelerated training.

(f) Initiative on the Part of Private Industry

84. Big industrial firms organise and run training courses at various levels to meet their individual needs. A few typical examples are given below:

(1) The Gas and Electricity Company in Lisbon, a private company with about 4,000 employees, holds three- to four-year courses to train skilled labour in several fields such as rotor rewinding, central sub-station techniques, electrical fitting, telecommunication installations, underground distribution, etc. A common basic course preceeds the specialisation courses mentioned above. The same company holds short "adaptation" courses for graduates of Industrial Schools. The company officials claim that these graduates have been exposed to unnecessary theoretical training and that, in general, they dislike manual work.

(2) "LISNAVE" is a big ship-building company (over 5,500 employees) in Lisbon. The Company's active participation in the training of skilled labour started 20 years ago in the form of support for the official apprenticeship courses then in operation; ten years later, however, the Company started its own apprenticeship school. According to company officials, the results in both cases were poor, the main handicap being the long period required to acquire the required skill, and the fact that school attendance, even on a part-time basis, had a negative influence on the apprentices' attitude towards manual work. It is for this reason that the Company decided, some three years ago, to put into operation an accelerated training scheme to meet its own requirements in skilled labour. The training courses now available, last one or two months and are designed for adults (23-35 years of age) mostly unemployed; a a psycho-technical test is required for recruitment. For each speciality there are three courses available at three different grades (a, b and c). Graduates of Industrial Schools also take such courses before being recruited. Ten specially trained instructors operate the scheme under the supervision of a training officer. It is estimated that over 1,300 persons have been trained in this way, with excellent results, during the past two years.

(3) "SOREFAME" is a metal construction industry (bridges, railroad coaches, boilers, etc.) with a total labour force of about 2,000. The company has a training section, mainly for welding, for 14 to 16 year old employees. The course, which lasts six months, includes five hours practical training a day and concludes with a test organised by the company. Most of the trainees have apprenticeship contracts and take theoretical subjects in neighbouring industrial schools, or are enrolled in evening industrial courses (paragraph 76). The enterprise makes also use of the services of the National Industrial Research Institute (paragraph 32) for training in administration and supervision. To this effect courses started in May 1964 and constitute an important training activity of the enterprise.

XI. COMMERCIAL EDUCATION

85. Commercial education is under the jurisdiction of the Ministry of Education; its structure is similar to that of industrial education, and comprises:

(a) Commercial Schools

86. These correspond to industrial schools, i.e. offer vocational courses at secondary level. At present, courses are available in general commerce and in shorthand-typing; each lasts three years and includes about 60 per cent of general subjects including foreign languages, and 40 per cent of commercial and other special subjects as shown in Table 16. On completing the course pupils may undergo a period of practical work, but this, in most cases, is optional.

87. Admission to commercial schools is granted to those completing the two-year preparatory vocational course (paragraph 12) or two years in a general secondary school. Students who have successfully completed the second year of a commercial course may follow a special one-year preparatory course for entrance to commercial institutes (Table 16).

(b) Commercial Institutes

88. Commercial Institures offer post-secondary courses of the same standard as the course given in industrial institutes (paragraph 37). At present there are three such institutes catering for some 2,360 (1964/65) students. Courses last three years and provide training for administrative assistants, accountants, customs experts, or foreign language correspondents.

89. Admission to Commercial Institutes is granted after passing an entrance examination, to individuals possessing qualifications similar to those demanded for the Industrial Institutes (paragraph 38). On completing their formal training, and before graduation, students have to work in private or public enterprises, approved by the school, for at least three months.

(c) University Institutions for Commercial, Economic and Political Studies

90. At university level, education in commercial, economic and political science is provided by the Technical University of Lisbon in the Higher Institute of Economic and Financial Studies and the Higher Institute of Social Science and Overseas Policy and the Faculty of Economics in Oporto.

Table 16

Programme time-table for secondary level commercial courses

(instruction periods per week)

	General commerce (years)			Shorthand typing (years)			Prep. course to commercial institutes 3rd year
	1	2	3	1	2	3	
Mother tongue	3	3	3	3	3	3	3
French	5	5	5	5	5	5	2
English	2	5	5	2	5	6	5
Religion	1	1	-	1	1	-	-
Geography	3	-	-	3	-	-	-
History	-	2	2	-	2	2	2
Natural science	3	3	-	3	3	-	3
Physics and chemistry	-	-	-	-	-	-	4
Hygiene	-	1	-	-	1	-	-
Union training(1)	-	-	1	-	-	1	-
Physical education	1	1	1	1	1	1	-
Mathematics	-	-	-	-	-	-	4
Commercial arithmetic	3	3	-	3	3	-	-
Elements of commerce and economics	3	2	2	3	2	-	-
Accountancy	-	4	6	-	-	-	6
Selling techniques	-	-	1	-	-	-	-
Calligraphy	3	-	-	3	-	-	-
Typewriting	-	-	4	-	3	5	-
Shorthand	-	-	-	-	5	8	-
	27	30	30	27	34	31	29

(1) Formação Corporativa

91. Admission to Higher Institute of Economic and Financial Studies and Faculty of Economics is granted to applicants who have passed the final examination of the corresponding third cycle of a general secondary school (paragraph 10) and to those who have completed the second year of a Commercial Institute together with a course in philosophy. In either case candidates must also pass an entrance examination unless they had obtained in the general average of the above-mentioned qualifications and in certain subjects considered as "basic" the minimum rating of "good".

92. The Institute of Social Sciences and Overseas Studies admits candidates who have completed the third cycle of a general secondary school (any type) or any of the courses of the Technical Institutes allowing entrance to the Technical University. Candidates must also pass the entrance examination in Portuguese, geography and political and administrative organisation, unless they had a "good" or higher average rating in their qualifications.

93. The length of studies for a first degree (licenciatura) in all three institutions is five years. The Institute of Social Science and Overseas Policy also offers a three-year undergraduate course in overseas administration which can be supplemented by a two-year course leading to a degree in advanced overseas studies.

94. The Higher Institute of Languages and Administration, a private institution, provides three-year courses for translators and interpretors and two and three-year courses for management and personnel relations. Admission is based on the completion of the third cycle of a general secondary school; entrance examination is not required.

95. Another private institution - the Evora Economic and Social Institute - offers two types of courses (economic and social) with a view to training industrial leaders and to providing tuition in social matters. Admission to this Institute is open to candidates who have completed the third cycle of a general secondary school (only certain parts of it for the economic course) and to students of Commercial Institutes who possess the necessary qualifications for entrance to higher education institutions (paragraph 91).

(d) Commercial Apprenticeship

96. Commercial apprenticeship courses have a similar structure to that of the industrial apprenticeship courses; they last four years at a rate of 12 instruction periods per week during the first year and 13 during the second, third and fourth years. The programme of instruction includes general and special subjects as shown in Table 17. There is only one specialisation available (general commerce).

Table 17

Programme time-table for an apprenticeship course in general commerce

(instruction periods per week)

Subjects	Years: 1st	2nd	3rd	4th
Mother tongue and history	2	2	2	3
French	2	2	2	2
Religion	1	1	–	–
Hygiene	–	–	1	–
Union training(1)	–	–	–	1
General and economic geography	2	2	2	–
Elements of commerce and applied legislation	–	2	2	–
Commercial arithmetic	3	2	2	–
Book-keeping	–	–	2	4
Calligraphy	2	2	–	–
Typewriting	–	–	–	3
	12	13	13	13

(1) Formação Corporativa.

XII. AGRICULTURAL EDUCATION

97. Agricultural education comes under the vocational education and training system of the Ministry of Education and comprises the following:

(a) Practical Agricultural Courses

98. These correspond to the courses given by the Industrial Schools and are provided by the "Practical Agricultural Schools", Entry requirements are two years of general education or completion of the preparatory vocational course (paragraph 12) which can be attended in the very Agricultural Schools. Training lasts two years, and consists of about 50 per cent practical work and 50 per cent general subjects and related theory. On the completion of the course, and after six months of practical work, trainees are eligible to take the examination for the skilled farm workers certificate (agente rural).

(b) Farm Management Training Schools

99. These schools provide training for upper-level agricultural technicians (regente agrícola). Entrance requirements are two years of general secondary education, or completion of the preparatory vocational course (paragraph 12), plus a pass in an examination in French. Training lasts five years and is followed by a practical work period of at least six months, after which graduates are qualified for managing large estates. They may also enter, after passing an entrance examination, the Higher Institute of Agronomy or the College of Veterinary Medicine for higher studies; for this purpose a preparatory one-year course is provided by the same farm management schools.

(c) Higher Agricultural Education Institutions

100. Agricultural education at university level is provided by the Higher School of Veterinary Medicine and the Higher Institute of Agronomy of the Technical University of Lisbon. Both institutions provide five-year courses but an additional year of practical work is required before graduation; a doctoral degree is also available. Admission is granted after passing an entrance examination to those who have completed the third cycle of the corresponding section (paragraph 10) of a general secondary school (liceu) and to graduates of Farm Management Training Schools (paragraph 99); candidates may, under certain conditions, (good or higher rating in their school leaving certificate), be exempt from entrance examinations.

(d) Agricultural Apprenticeship

101. Agricultural apprenticeship is organised along similar lines to those for industrial and commercial apprenticeship; it starts after completion of primary education and lasts four years.

Trainees are expected to work in farms and other agricultural undertakings. Complementary courses are provided free by the practical agricultural schools (paragraph 98) at the rate of 10 instruction periods per week. During the two first years, theoretical instruction is limited to six months each year and the programme includes general subjects (mother tongue, history, arithmetic and geometry), technical drawing, and nature study; thereafter instruction extends over the whole school year and includes technical subjects such as horticulture, gardening, technology of agricultural products, agricultural machines and equipment, etc.

(e) Refresher and Other Short Courses in Agriculture

102. Refresher courses are intended for adults who wish to improve their qualifications but have an adequate general educational background. The content of the courses, the length of training and the admission requirements vary widely and are fixed each year at ministerial level. Similar short courses in specific fields are provided for adult farmers by the extension services of the Ministry of Agriculture.

XIII. HOME ECONOMICS, HOTEL, CATERING AND TOURISM COURSES

103. Parallel to the lower-level industrial and commercial courses, are under the Ministry of Education, some home-economics courses, leading to a professional certificate in general home economics (formação feminina) or in embroidery/dress-making. Both are three year courses and include general and special subjects as shown in Table 18.

Table 18

Programme time-table for general home-economics and dress-making/embroidery courses

(instruction periods per week)

Subjects	General home-economics			Dress-making/ embroidery		
	(years)			(years)		
	1	2	3	1	2	3
Mother tongue	3	3	3	3	2	2
French	5	5	-	-	-	-
Religion	1	1	-	1	1	-
Mathematics	3	3	-	-	-	-
Hygiene and child care	1	1	1	1	1	1
Physical education	1	1	1	1	1	1
Drawing	8	8	8	8	8	8
Domestic economy	1	1	1	1	1	1
Typewriting	-	-	4	-	-	-
Workshop practice	18	20	24	18	20	24
Total	41	43	42	33	34	37

104. Further specialisation courses are available in dress-making, underwear, millinery, needle-work and embroidery design, (Table 5 and paragraphs 34 and 35).

(b) Hotel, Catering and Tourism

105. Training in the hotel, catering and tourist trades proper is initiated by several private institutions; some are approved and subsidised by the government. The recently established (1965)

Centro Nacional de Formação Turística e Hoteleira (National Centre for Hotel and Tourist Training) is expected to co-ordinate several activities, some of which are briefly described below:

(i) The Escola Hoteleira de Lisboa (Hotel School of Lisbon) is a recognised semi-governmental institution to providing training in hotel and catering trades. The school offers elementary courses lasting two years (after four years of primary schooling), and advanced courses based on the elementary courses supplemented by two years of practical experience; the latter last four to seven months and cover several fields, including hotel administration and reception. Total enrolment in 1965 was about 260.

(ii) The Escola Portuguesa de Turismo (Portuguese School of Tourism) provides training at post-secondary, non university (upper technician) level in foreign languages and hotel administration. The Instituto das Novas Profissões (Institute of New Professions) also includes similar courses in tourism in its syllabus.

(iii) Two more institutions, the Escola Hoteleira de Algarve and the Escola Hoteleira da Madeira are now under construction as a joint private industry-government venture.

Part Three

FUNCTIONS OF TECHNICIANS

XIV. TECHNICIANS AND THEIR OCCUPATIONS

106. A simple quantitative comparison of enrolments in the several levels and types of education (see Table 2) reveals that training at the upper-technician level has not yet been given proper consideration. Of a total of 298,527 students in secondary and post-secondary (non university) education in 1964/65, only 5,000 were in commercial and industrial institutes. According to the M.R.P. study(1), 22,800 diplomas should be granted by these institutes during the period 1960-1975; it is therefore considered that, with the present trend (179 diplomas in 1956/57, 128 in 1960/61, 233 in 1964/1975), not even half of the needs can be covered.

107. For craftsmen and lower level technicians in industry and commerce, prospects are much more promising. In 1964/65, 21,951 diplomas were granted by industrial and commercial schools as compared with 6,851 in 1956/57. During the same year diplomas granted by liceus (first, second and third cycles) were 39,370 and 22,254 for 1964 and 1965 respectively.

108. There are no precise data available concerning the distribution of industrial upper-level technicians by sector of economic activity. Their total number is estimated to be about 5,000 and the technician/university engineer ratio 1:4. About half the technicians are organised in a common association, the "Sindicato dos Engenheiros Auxiliares, Agentes Técnicos e Condutores"; this association is primarily concerned with professional matters, its main target being to extend, and gain legal recognition of the professional rights of its members so as to bring them nearer to university engineers. The latter, who are organised in a separate association - the "Ordem dos engenheiros", react negatively to this attitude on the part of the technicians and insist that the real problem lies in a wrong conception of the role of a technician in industry.

109. Salaries of both engineers and technicians are higher in private industry than in the public sector. A junior engineer may start his career in private industry with a monthly salary of approximately Esc. 6,000-6,500; this may increase to Esc. 8,000-9,000 in two years and then to Esc. 11,000-12,000 in five years. Technicians usually start at Esc. 4,500 a month, but when they have acquired considerable experience then salaries compare favourably with those of university engineers. Table 19 gives an indication of the situation in the Civil Service.

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(1) O.E.C.D. Mediterranean Regional Project - Portugal, Paris 1966.

Table 19

Estimated monthly salaries of university engineers and technicians in the Civil Service (1965)

(Escudos)

Grade(1)	Univ. Engineer	Technicians (upper level)
III	4,000	2,800
II	5,400	3,400
I	6,500	3,800
Doctorate	8,000-10,000	-

(1) Grades II and I demand additional qualifications or industrial experience

Source: Ordem dos engenheiros

XV. AN INDUSTRIAL SURVEY

110. In the absence of a special survey on the functions of technicians in industry, on-the-spot investigations were extended to include a sample survey of large representative enterprises in the engineering and electricity production industries and industrial and other professional associations. The training programmes of some of the industries are briefly described in paragraph 84; information concerning the distribution and functions of the technical staff are summarised below.

111. Visits included: (i) the Gas and Electricity Company; (ii) Standard Electric; (iii) SOREFAME, metal industry; (iv) LISNAVE, ship building industry. These enterprises employ a total labour force of over 15,000 and are considered as representative examples of the large-scale Portuguese metal and electricity production industry.

112. The Gas and Electricity Company is a private firm comprising a central generating station in Lisbon and ten substations in other regions of the country. This company produces and supplies 25 to 30 per cent of the total electric power used in Portugal. The labour force numbers more than four thousand and is broken down by category of skill as shown in Table 20.

Table 20

Breakdown of labour force, by category of skill in the Gas and Electricity Company (Central Station and branches) 1966

Category of skill	Number	Percentage of total
University engineers	76	1.8
Upper-level technicians	75	1.8
Lower-level technicians and craftsmen	1,483	37.1
Electricians	809	
Electrical fitters	175	
Draftsmen	82	
Others	417	
Machine operators	421	10.5
Unskilled workers	431	10.8
Non-technical personnel	1,519	38.0
Administrative	847	
Commercial	395	
Bureau - assistants	277	
	4,005	100.0

113. Only 4 per cent of the lower-level technicians and craftsmen are graduates of industrial schools, the rest being recruited from among primary or general secondary school graduates and trained as indicated in paragraph 84(i). The Company's officials consider that the scarcity of technicians, particularly upper level, has a serious repercussion on technical progress in general and claim that the number of upper-level technicians in the Gas and Electricity Company should be at least four times as big so as to raise the ratio of upper level technician/university engineer to 3:1.

114. The officials in charge consider that the salaries of technical staff depend mainly on the personal ability of the employee. Although upper-level technicians usually work under the supervision of university engineers, it is possible for a technician to earn more than an engineer. In general, the monthly salaries of technical staff vary with the years of service and the responsibilities they are assigned, as follows: University engineers - Esc. 6,000-12,000; upper-level technicians - Esc. 5,000-8,000; industrial school graduates - Esc. 3,000-5,000.

115. Standard Electric is a branch of the corresponding British enterprise specialising in the manufacture of electrical equipment and apparatus; of the total of more than a thousand employees, 40 are university engineers, 12 industrial-institute graduates (upper-level technician), and 40 have completed an industrial school course. The structure of the labour force is as follows:

Office personnel		130
Technical staff		850
of which:		
draftsmen and designers	60	
production control	40	
skilled workers	200	
unskilled workers	550	
Total		930

116. Company's officials claim that their engineers and technicians, in general, have a sound technological background but lack practical experience and have great difficulty in adapting themselves to the world of industry. To overcome this difficulty, the company adopted a special training scheme consisting of a short preliminary course followed by a practical training period abroad in other company's laboratories and workshops. For lower-level skilled personnel, the company provides locally short training courses.

117. Salaries of university engineers start with a monthly average of about Esc. 6,000 and those of upper-level technicians with Esc. 5,000, provided they have completed the actual course and the subsequent practical training required (paragraphs 40 and 50). Lower-level technicians and skilled workers who have completed an industrial school course, start with Esc. 2,000 to 2,500 a month.

118. "LISNAVE" is a large ship-building company in Lisbon; 51 per cent of the capital is Portuguese, and 49 per cent foreign (24.5 per cent Dutch, 24.5 per cent Swiss). In October 1965, 3,154 persons were employed by the company; the structure of the labour force was as follows:

university engineers	39	(of whom 9 in administration)
upper-level technicians-graduates of industrial institutes	41	(of whom 2 in administration)
other upper-level technicians	4	
lower-level technicians and skilled workers graduates of industrial schools	250	
other skilled workers	1,500	
unskilled workers	850	
administrative and other staff	470	
Total	3,154	

119. Salaries of university engineers start at approximately Esc. 5,000 per month but rise to Esc. 6,000 after six months of satisfactory service; thereafter, the rate and size of increments largely depends on the ability of the individual. Upper-level technicians start with Esc. 3,500 per month, which is increased to 4,000 after 12 months of satisfactory performance; competent technicians may climb quickly and, in a few years, receive salaries which compare favourably with those of university engineers. Graduates of industrial schools are recruited as unskilled workers and are promoted to skilled workers only after three years of satisfactory performance and further training within the firm as mentioned in paragraph 84(ii).

120. SOREFAME is a metal industry specialising in the construction of rail coaches, bridges, boilers and other metal structures. The Company was established in 1944 as a Portuguese private enterprise with a small participation of French industrialists.

121. In November 1966, the structure of the labour force was as follows:

university engineers	45
upper-level technicians (graduates of ind. institutes)	30
draftsmen	100
skilled and unskilled workers	1,300
administrative and other personnel	200
Total employed	1,675

The relatively high proportion of draftsmen is due to the fact that the company operates a large development and research department. About 50 per cent of the draftsmen received their training in accelerated courses organised by the "Manpower Development Fund" (paragraph 78). The proportion of unskilled workers as a whole is very low; practically every worker in production has had some sort of technical training in an Industrial School, in an accelerated training centre, or within the Industry.

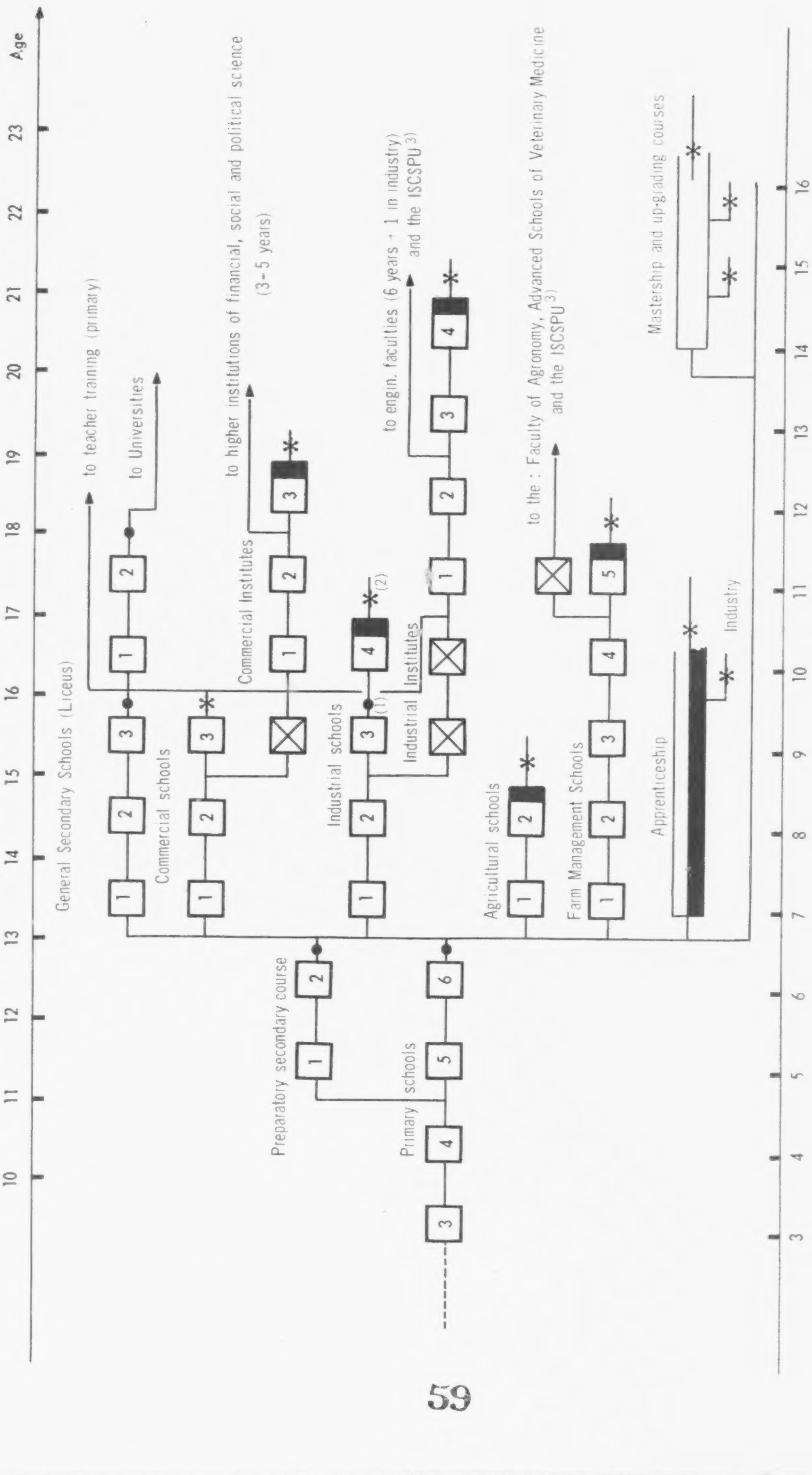
122. University engineers are in charge of major projects or are heads of departments, while upper-level technicians act as supervisors for construction or assist the engineers; one of them is in charge of the maintenance department. Foremen are, in general, graduates of Industrial Schools but some have only industrial experience supplemented by special short courses. University engineers start with approximately Esc. 5,500 and upper-level technicians with Esc. 4,250 per month. Although the rate and size of increments depend on the ability of the individual, in general, the percentage difference between the salaries of engineers and technicians is constant.

123. Company officials claim that there is a real scarcity of qualified technicians; of the 30 upper level technicians employed in 1966 only ten had completed their studies, including the practical stage, and received a diploma. The same officials contend that the industrial institute courses should be revised to cater for the real needs of industry; at present they are advanced on the theoretical side but provide the students with insufficient practical and operational experience.

APPENDICES

Appendix I

PRINCIPAL TECHNICAL AND VOCATIONAL SCHOOLS/COURSES WITHIN THE EDUCATIONAL SYSTEM
(after implementation of the 1964 reform)


Age
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23
to teacher training (primary)
to Universities
to higher institutions of financial, social and political science (3-5 years)
to engin. faculties (6 years + 1 in industry) and the ISCSPU 3)
to the : Faculty of Agronomy, Advanced Schools of Veterinary Medicine and the ISCSPU 3)
Mastership and up-grading courses
General Secondary Schools (Liceus)
Commercial schools
Commercial Institutes
Industrial schools
Industrial Institutes
(1)
(2)
Agricultural schools
Farm Management Schools
Apprenticeship
Industry
Preparatory secondary course
Primary schools
3
4
5
6
7
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9
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11
12
13
14
15
16

☒ Preparatory course.
● Completion of a cycle or course.
▬ Training or work in industry.
* Qualifying examinations.

1. Certain courses last four years.
2. Certain courses last two years.
3. Higher Institute of Social Science and Overseas Policy.

Appendix II

INDUSTRIAL AND COMMERCIAL SCHOOLS/COURSES

A. Courses available by branch of specialisation, enrolments and output: 1964/65.

B. Lower-level technician courses - Selected programme time-tables.

C. Craftsman courses - Selected programme time-tables.

D. "Mastership" courses - Selected programme time-tables.

E. Courses preparatory to Industrial Institutes.

A. Courses available by branch of specialisation, enrolments and output 1964/65

		Enrolments	Output
1.	Preparatory courses	52,754	16,859
	preparatory vocational cycle	49,290	15,837
	preparatory to industrial and commercial institutes	3,464	1,022
2.	Metal work - drawing	16,583	622
	general metal-work	16,412	593
	machine shop	14	6
	chisel work	25	-
	foundry	11	-
	gold smithing	21	-
	mechanical drawing	100	23
3.	Auto-mechanics	23	1
4.	Electricity-radio	13,317	378
	electrical installations	2,276	93
	electro-mechanics	2,178	29
	electrical fitting	7,854	239
	radio-electrical fitting	1,009	17
5.	Wood-work	1,048	107
	carpentry	332	17
	cabinet making	607	79
	wood carving	31	6
	artistic furniture making	39	2
	mould making	39	3
6.	Quarrying - construction	310	64
	stone work (quarrying)	3	-
	drawing (architectural)	21	11
	topography	21	2
	building contractors (assistant)	245	44
	work supervisors	20	7
7.	Graphic arts	668	39
	printing: press work	95	8
	printing: composition	103	10
	lithography	346	11
	engraving: copper, bronze, steel	36	3
	engraving: photo-chemical	58	4
	book binding	30	3

		Enrolments	Output
8.	Textiles	507	25
	textile technician	176	8
	spinning	76	4
	textile mechanics (machine weaving)	57	5
	weaving (assistant)	167	7
	dyeing and finishing	31	1
9.	Decorative arts	736	58
	decorative painting	609	45
	decorative sculpture	50	3
	decorative ceramics	77	10
10.	Chemistry	1,983	90
	chemical laboratory technician	1,983	90
11.	Training for women	7,947	1,169
	home economics	7,779	1,094
	embroidery	141	63
	dress-making	27	12
12.	Commerce	43,801	2,487
	general commerce	43,746	2,473
	shorthand typing	55	14
13.	Miscellaneous	652	55
	industrial training (general)	152	43
	watch making	19	1
	ceramics	10	3
	paper making	15	4
	glass making	45	4
	other	411	-
		140,329	21,954

Source: I.N.E. (Estatística da Educação 1964/65).

B. Lower-level technician courses Selected programme time-tables

1. Radio-electrical fitting

Subjects	Instruction periods/week				Totals	
Years:	1	2	3	4	Units (1)	%
a. General subjects	7	7	4	3	21	12.5
mother tongue	3	2	–	–	5	
English	2	3	3	–	8	
religion	1	1	–	–	2	
hygiene	–	–	–	1	1	
union training(2)	–	–	–	1	1	
legislation and insurance	–	–	–	1	1	
physical training	1	1	1	–	3	
b. Mathematics, science and technology	19	17	16	14	66	39.5
mathematics	4	3	–	–	7	
applied mathematics	–	–	3	3	6	
physics and chemistry	4	3	–	–	7	
elements of electricity	3	4	–	–	7	
elements of electronics	–	–	5	5	10	
telecommunication principles	–	–	2	3	5	
mechanical technology	2	–	–	–	2	
radio technology	–	3	3	–	6	
mechanical drawing	6	4	–	–	10	
schematic drawing	–	–	3	3	6	
c. Laboratory work	2	4	10	12	28	16.5
electricity	2	4	–	–	6	
measurements	–	–	4	4	8	
radio	–	–	6	8	14	
d. Workshop practice	12	14	13	14	53	31.5
metalwork	9	–	–	–	9	
electricity	3	14	–	–	17	
radio-assembling	–	–	9	4	13	
radio-repairs	–	–	4	10	14	
Totals	40	42	43	43	168	100.0

(1) one unit = 36 periods of instruction (approximately).

(2) Formação Corporativa.

2. Chemical laboratory assistant course

Subjects	Instruction periods/week				Totals	
	Years	1	2	3	Units(1)	%
a. General subjects		8	10	2	20	25.5
mother tongue		3	2	–	5	
French		3	5	–	8	
religion		1	1	–	2	
hygiene		–	1	–	1	
physical training		1	1	1	3	
union training(2)		–	–	1	1	
b. Mathematics and Science		11	9	10	30	38.5
mathematics		3	3	–	6	
elements of physics		4	–	–	4	
general chemistry		4	4	–	8	
chemical technology		–	2	6	8	
analytical chemistry		–	–	4	4	
c. Laboratory work		8	8	12	28	36.0
chemical laboratory		8	8	12	28	
Total		27	27	24	78	100.0

(1) One unit = 36 instruction periods (approximately).

(2) Formação Corporativa.

3. Textile Technician course

Subjects	Instruction periods/ week				Totals	
Years:	1	2	3	4	Units (1)	%
a. General subjects	8	9	4	1	22	13.5
mother tongue	3	2	2	–	7	
French or English	3	5	–	–	8	
religion	1	1	–	–	2	
hygiene	–	–	1	–	1	
union training(2)	–	–	–	1	1	
physical training	1	1	1	–	3	
b. Mathematics, science, and technology	15	19	22	23	70	49.0
mathematics	3	3	–	–	6	
elements of physics and chemistry	4	4	–	–	8	
general and applied mechanics	–	2	2	–	4	
elements of electricity	–	–	–	2	2	
technical drawing (mechanical, artistic, decorative)	8	4	4	4	20	
textile materials	–	2	–	–	2	
textile technology	–	2	4	5	11	
chemistry of textiles	–	–	2	2	4	
designing for fabrics, analysis and calculations	–	–	6	6	12	
laboratory work (on textiles)	–	2	4	4	10	
c. Workshop practice	16	15	15	15	61	37.5
metal work	12	–	–	–	12	
spinning	–	6	6	–	12	
weaving	4	9	9	15	37	
Totals	39	43	41	39	162	100.0

(1) one unit = 36 periods of instruction (approximately).

(2) Formação Corporativa.

C. Craftsman courses - Selected programme time-tables

1. General Metal

Subjects	Instruction periods/week			Totals	
	1	2	3	Units(1)	%
a. General subjects	5	4	4	13	10.5
mother tongue	3	2	-	5	
religion	1	1	-	2	
hygiene	-	-	1	1	
book-keeping	-	-	1	1	
union training(2)	-	-	1	1	
physical training	1	1	1	3	
b. Mathematics, science and technology	16	18	16	50	40.5
mathematics	3	3	-	6	
elements of physics and chemistry	4	3	-	7	
elements of electricity	-	2	-	2	
elements of general mechanics (theory and practice)	-	-	2+2	4	
technology	1	2	4	7	
technical drawing	8	8	8	24	
c. Workshop practice	18	20	22	60	49.0
metal workshop	18	20	22	60	
Totals	39	42	42	123	100.0

(1) one unit = 36 instruction periods (approximately).

(2) Formação Corporativa.

2. Carpentry - cabinet making

Subjects	Instruction periods/week			Totals	
	1	2	3	Units(1)	%
a. General subjects	5	5	3	13	11.5
mother tongue	3	2	-	5	
religion	1	1	-	2	
hygiene	-	1	-	1	
union training(2)	-	-	1	1	
budgeting and costing	-	-	1	1	
physical training	1	1	1	3	
b. Mathematics, science and technology	13	13	10	36	32.5
mathematics	3	3	-	6	
technical drawing	8	8	8	24	
technology	2	2	2	6	
c. Workshop practice	18	20	24	62	56.0
wood workshop	18	20	24	62	
Totals	36	38	37	111	100.0

(1) one unit = 36 periods of instruction (approximately).

(2) Formação Corporativa.

D. Mastership courses - Selected time-tables

1. Civil construction (part-time course)

Subjects	Instruction periods/ week				Total
Years:	1	2	3	4	Units(1)
Mother tongue	2	-	-	-	2
Arithmetic - algebra	2	-	-	-	2
Geometry - trigonometry	2	-	-	-	2
Descriptive geometry (applied)	2	2	-	-	4
Physics	1	1	-	-	2
Chemistry	1	-	-	-	1
Mechanics	-	2	-	-	2
Resistance of materials	-	2	2	-	4
Construction drawing	6	6	6	-	18
Construction materials	-	3	-	-	3
Construction processes	-	-	3	2	5
Topography	-	-	2	-	2
Reinforced concrete and metallic constructions	-	-	3	1	4
Buildings I(2)	-	-	-	3	3
Buildings II(3)	-	-	-	6	6
Estimates and costing	-	-	-	2	2
Legislation	-	-	-	1	1
Organisation of work-safety rules	-	-	-	1	1
Totals	16	16	16	16	64

(1) one unit = 36 instruction periods (approx.)

(2) foundations - modern building techniques - installations - industrial buildings - cracks in buildings.

(3) proportion of buildings - pillars - architectural details.

2. Canning(1) (full-time course)

Subjects	Instruction periods/week				
	A(2) 1st	B(3)	2nd	3rd	4th
Mathematics	2	2	-	-	-
Chemistry - elements of analytical chemistry	-	4	-	-	-
Electricity	-	-	2	2	-
Technical drawing	8	-	2	2	2
Applied chemistry	-	-	4	4	2
Applied physics	2	2	2	-	-
Applied zoology and botanics	3	3	3	-	-
Foodstuffs	2	2	2	-	-
Preparation and canning of foodstuffs	-	-	2	2	-
Technology of canning	-	-	2	2	2
Financial organisation of a factory	-	-	-	6	6
Physiology, microbiology, enzymes and vitamins	-	-	-	4	4
Industrial organisation and legislation	-	-	-	1	1
Costing	-	-	-	-	1
Factory hygiene	-	-	-	-	1
Chemical and biological laboratory work	-	12	12	12	12
General workshop practice	16	-	-	-	-
Practical work (canning of fish, fruits, vegetables, meat)	-	-	10	8	10
Totals	33	25	41	43	41

(1) In this course are accepted only those who: have completed the basic vocational course in chemistry or in metal disciplines, are 18 years of age or more and have at least two years of practical experience in a canning factory.

(2) Only for those who have completed a basic course in chemistry.

(3) Only for those who have completed a basic course in metal work.

E. Courses preparatory to Industrial Institutes

These courses start after the second year of certain basic courses; the programme varies with the basic course followed as shown in the example below:

Subjects	Basic course followed					
	Chemical lab. asst.		Electro-mechanics		Carpentry/ cabinet making	
	3rd	4th	3rd	4th	3rd	4th
Mother tongue	3	2	2	2	2	2
English	3	5	3	5	3	5
French	-	-	3	5	3	5
History	-	3	-	3	-	3
Geography	3	-	3	-	3	-
Mathematics	3	3	3	3	3	3
Natural science	2	2	2	2	2	2
Physics and chemistry	3	3	3	3	3	3
Technical drawing	4	4	2	2	4	4
Technology	6(1)	-	2(2)	2(2)	2(3)	-
Chemical analysis	4	-				
Electricity (theory and practice)	-	-	4	4		
Laboratory work	4	8	8(4)	8(4)	8(5)	8(5)
Workshop practice						
Total instruction periods/week	35	30	35	39	33	35

(1) chemical;

(2) mechanical, electrical;

(3) electrical;

(4) metal work, electricity;

(5) wood-work.

Appendix III

UPPER-LEVEL TECHNICIAN COURSES

A. Examples of entrance examination paper in the Industrial Institutes (Lisbon 1963).

B. Curriculum outline in selected subjects.

A. EXAMPLES OF ENTRANCE EXAMINATION PAPERS TO THE INDUSTRIAL INSTITUTES (LISBON 1963)

1. PHYSICS

(1) Give a definition of linear velocity and angular velocity.

What is the linear velocity of a particle of 2 g which is moving along a circle of a diameter of 1 m with the constant angular velocity of 20 rev/min?

To what force is this particle subjected?

(2) If the relative density of a certain substance is 8.9 what is its specific mass? Justify your answer.

Describe a method for the determination of the density of a solid.

(3) A body of 4 kg is moved by the action of a constant force F. The equation of the motion of the body is $e = 9 t^2$.

Of what type is this motion? What is the value in kg of the force F? What work does this force do during the first two minutes of its action?

(4) Give a definition of the specific heat of a substance, and of the heat-absorption capacity of a body.

If 148 cal. are delivered to a body with a heat-absorption capacity of 10 cal/degree, what will be the rise of temperature of the body?

(5) What is the power of a converging lens with a focal distance of 10 cm?

What is the magnitude of the image formed by this lens of an object with a height of 5 cm, placed at a distance of 30 cm from the lens? At what distance from the lens will this image be formed?

(6) What is understood by electric resistance of a conductor?

If a tension of 32 V is applied to a conductor with a resistance of 2 ohms, what current will flow through it?

If this conductor has a length of 100 m and a diameter of 1 mm, what is the resistivity of the material of the conductor?

2. CHEMISTRY

(1) What compound is produced by the reaction of oxygen with magnesium? Write down the chemical equation which represents this reaction and calculate the volume of the oxygen that totally reacts with 81 grams of magnesium.

$O = 16 \qquad Mg = 24.3$

(2) What is understood by:

a - The atomic weight of an element
b - Bases or hydroxides
c - Oxydizing substance
d - Synthesis

(3) Complete the following chemical equations:

a - $SO_4H_2 + CO_3Ca \longrightarrow$

b - $ClNH_4 + OCa \longrightarrow$

c - $SO_4H_2 + NO_3Na \longrightarrow$

(4) What weight of copper is necessary for the production of 100 g crystallized sulphate of copper ($SO_4Cu, 5OH_2$)? What is the weight of the corresponding dehydrated sulphate of copper?

$S = 32 \quad O = 16 \quad H = 1 \quad Cu = 63.6$

(5) Calculate the weight of the alcohol produced by the fermentation of 18 grams of glucose.

$C = 12 \quad O = 16 \quad H = 1$

(6) Referring to sulphur dioxide, describe:

a - its physical properties
b - its industrial applications
c - the process of its preparation in the laboratory
d - the process of its industrial production

3. MATHEMATICS

(a) Arithmetic

(1) Decompose into prime factors the numbers 990 and 2145.

(2) Determine the greatest common divisor and the least common multiple of the numbers 72, 75, 80.

(3) Reduce to its simplest forms the fractions $\frac{6}{24}$, $\frac{30}{42}$, $\frac{27}{45}$ and $\frac{60}{96}$ and proceed in increasing order.

(4) Classify the fraction $\frac{73}{99}$. Reduce this fraction to a decimal quotient and classify the decimal fraction obtained.

(5) 50 g. of a solution contains 0.8g. of salt. Determine the concentration of the solution in %.

(6) Complete in the following table the series of values corresponding with the quantity B so as to make this quantity inversely proportional to the quantity A.

Quantity A	0.14	2.1	28
Quantity B	-	4.0	-

(b) Algebra

(1) Transform the fraction:

$$\frac{a^{-2} + b^{-2}}{a^{-1} - b^{-1}}$$ so that it will only show whole and positive exponents.

(2) Resolve graphically the system of equations $\begin{cases} x + 2y = 5 \\ 3x - y = 1 \end{cases}$

(3) Reduce the fraction $\frac{4x - 12}{15 - 5x}$ to its simplest form.

(4) Resolve the equation $x^2 - 2x - 1 = 0$ showing the roots in their simplest form.

(5) Knowing that $\log 2 = 0.3010$ and $\log 30 = 1.4771$, determine the value of N given by $N = \log \frac{20}{\sqrt{0.03}}$

(6) The sum of the first three terms of an arithmetical series is 54 and the difference between the third and the first term is 24. Write down the first four terms of the series.

(c) Geometry

(1) One of the angles of a parallelogram measures 71° 58'; determine its other angles.

(2) The sides of an isosceles triangle (A B C) have the following relations: AB = AC = 2BC = 8. Calculate the surface of the triangle, approximated to tenths.

(3) Two straight lines D, D' intersect each other outside the sheet of paper; how would you proceed to measure the acute angle formed between the two lines? Justify your answer.

(4) Consider three points A, B, C, placed in this order on a circle with centre O, in such a way that the arcs AB and BC measure, respectively, 110° and 70°.

a - What value has the angle BOC?

b - Determine the angles of the triangle ABC.

c - Prove that the points A, O, C are located on a straight line.

(5) Determine the total area of a right circular cone whose base has a radius of 10 cm. and whose height is 24 cm.

(d) Trigonometry

(1) Knowing that A is an angle of a triangle, answer the following questions:

a - Why is $\sin A < 1$?

b - When is $\sin A = \cos A$?

c - Why is $\sin A < \text{tg } A$?

d - When is $\text{tg } A > 1$?

(2) Determine the values of the various trigonometric functions of the acute angle A, knowing that $\sin A = \frac{3}{7}$.

(3) Determine the perimeter of an isosceles triangle with a base of 40 cm. and a basic angle of 70° 15'.
Use the natural values from the following table:

A	sin A	cos A	tg A
68°	0.928	0.373	2.485
69°	0.934	0.357	2.616
70°	0.940	0.341	2.760
71°	0.946	0.324	2.913
72°	0.952	0.308	3.093

4. DRAWING

(1) Project on the horizontal and vertical planes a right, regular, triangular prism with a height of 30 cm, whose base is inscribed in a circle with a diameter of 20 cm and is parallel to the vertical plane at a distance of 5 cm therefrom.

The axis of the prism has a distance of 12 cm above the horizontal plane and one of its lateral faces forms an angle of 30° with the horizontal plane.

Use the scale 1:2.5 and indicate all dimensions in the drawing.

(2) Make from observation, a free-hand sketch of the horizontal, vertical and lateral projections of the model of which a perspective view is given here, and indicate the main dimensions lines.

B. CURRICULUM OUTLINE IN SELECTED SUBJECTS

1. MATHEMATICS

(a) Algebra

1st year

Division of polynomials by binomials of the form $x^m \pm a^m$. Discussion of the general equation of the 1st degree with one unknown quantity; infinite and indeterminate solutions. Indeterminate analysis of the 1st degree; study of the equation $ax + by = c$.

Discussion of the equation of the 2nd degree with one unknown quantity; laws concerning its composition - Trinomial of the 2nd degree; study and solutions of inequations of the 2nd degree - Irrational equations - Biquadratic equations - Graphical representation of the biquadratic binomial - Transformation of double radicals into simple radicals - Simultaneous equations - Problems of maximum and minimum values solvable by the indirect method; theorems. Analysis of sets: dispositions, permutations and combinations - Newton's binomial - Progressions. Development of the theory of logarithms and of the study of the function a^x; common and hyperbolic logarithms; modulus of a logarithm system; graphical representation of the function a^x; exponential equations. Compound interests and annuities - Determinants: definitions; general properties; minor of a determinant; theorems about the development of determinants; application of determinants to the solution of systems of equations. Cramer's rule. Rouché's theorem - Complex numbers; operations - Moivre's formula - Roots of real and complex numbers; roots of unity - Geometric representation of complex numbers and operations. Elements of the theory of functions: definitions and generalities - Limits - Continuity of functions. Infinitely small quantities. Elements of the theory of equations - Relationship between the coefficients of an equation and its roots - Transformation of equations. Transformations of x into $-x$, $\frac{1}{x}$, hx and $x-h$ - Nature of the roots of an equation - Descartes's theorem; Lacuna's theorem - Separation of the roots of an equation - Theorem of the substitutions. Rolle's theorem. Rolle's succession - Limits of the two roots; Newton's method - Determination of the measurable, whole and stationary roots of an algebraic equation - Graphical solution of equations.

(b) Plane Trigonometry

Vectors; geometric sum of vectors; Chasles' formula - Angles and arcs; their application. Unity of measure. The circular functions; definitions and study of their variations; sinusoids, tangentoids and secantoids. Formulae of relationship between the trigonometric curves Reduction to angles in the 1st quadrant and angles smaller than $\frac{\pi}{4}$ radians. Knowledge of some trigonometric curves

by consideration of the double arc - Inverse circular functions - Fundamental formulae of trigonometry. Projection formulae; cosine of the angle with two directions; projection of a vector on an axis; projection of a polygonal contour, expressed by means of the cosine - Formulae of angle operations. Logarithmic transformations; trigonometric equations; logarithmic calculation - Formulation of problems and deduction of the formulae which serve for the solutions of right angled triangles; theorems of sines and of projections; Carnot's theorem; formulae for the solution of oblique-angled triangles - Resolution of triangles; general and special cases - Applications in topography - Projection of a plane figure on a plane.

(c) Elements of differential calculus   2nd year

Derivative and differential of an explicit function; geometric interpretation; mechanical signification of the derivative - Successive derivatives - Derivative of a sum, a product, a quotient, a power and a radical - Derivative and differential of a function, a composite function and an explicit function.

Partial and total derivatives - Derivatives of exponential functions - Derivatives of exponential functions with hyperbolic logarithms or logarithms of any other base; derivative of circular functions, direct and inverse.

Series:

Definitions - Theorems about convergencies - Numerical and alternated series; series of complex terms; series of functions; trigonometric Fourier series - Numerical calculus - Graphical representation of series - Development of functions into series: Taylor and MacLaurin formulae; application to the development of the functions e^x, e^{-x}, sin x and cos x.

Hyperbolic functions:

Exponentials with complex exponent; its reduction to the trigonometrical form of complex functions - Euler's formulae - Geometric interpretation of the functions sh x, ch x, th x, by consideration of the equilateral hyperbola. Derivatives of hyperbolic functions - Hyperbolic functions of imaginary quantities.

Variation of functions:

General theorems - Increasing and diminishing functions - Maximum and minimum values of functions - Points of inflection - Elements of infinitesimal plane geometry - Graphical representation of functions - Variations of the angular coefficient of the tangent to a curve; geometrical interpretation; osculatory circle; evolutes and evolventes; concavity and convexity.

(d) Elements of Integral Calculus

Definitions and notations - Definite integral and indefinite integral - Analytical definition and geometrical signification of the definite integral - General properties of definite integrals - Mean value of a function - General rules of integration - Integration of rational, irrational and transcendental functions - Integration of total differentials. Applications of integral calculus to the evaluation of plane areas, to the rectification of curves and to the calculation of volumes of solids of revolution - Fundamentals of multiple integrals with applications to the calculation of areas and volumes - Centres of gravity of surfaces and volumes; moments of inertia - Simple differential equations with applications in the technical field - Graphical methods of differentiation and integration.

(e) Elements of analytical geometry

Co-ordinates: cartesian, rectangular and oblique co-ordinates, Polar co-ordinates - Transformation of co-ordinates - Straight line: deduction of its equation in cartesian co-ordinates; various forms of the equation of the straight line; normal equation; equation in polar co-ordinates; equation of the straight lines passing through a point or through two points. Co-ordinates of a point of a line segment related with the co-ordinates of the extremities - Distance between two points - Angle formed between two straight lines. Conditions of parallelism and perpendicularity - Equation of the perpendicular dropped from a point onto a straight line - Intersection of two straight lines - Distance from a point to a straight line. Algebraic and transcendental curves - Classification of algebraic curves by means of the degree of their respective equations - Symmetry of curves in relation with their axes - Equations of the tangent and the normal to a curve, in a point. Subtangent and subnormal - Asymptotic directions; asymptotes.
Study of the circle: its general equation on oblique axes, on rectangular axes and with polar co-ordinates - Special cases - Power of a point in relation to a circle -

Equations of the tangent and the normal to a circle.
Study of the ellipse: equation referring to the axes, equation of the tangent, of the normal, of the subtangent and of the subnormal - Parameter equations of the ellipse; diameters - The ellipse as a projection of a circle - Appollonius' theorem.
Study of the hyperbola: equation referring to the axes, equation of the tangent and of the normal - Parameter equations of the hyperbola - Diameters - asymptotes - equilateral hyperbola.
Study of the parabola: equations referring to the axis and to the tangent of its top; equations of the tangent and of the normal; parameter equations - diameters.
Construction of algebraic and transcendental curves: catenary, cycloid, epicycloid, etc.
Nomographic representation - Nomograms.

(c) Space geometry

Rectilinear, polar and cylindrical co-ordinates - Equation of a surface and equation of a line - Transformation of co-ordinates - Equation of a plane. Special cases. Intersection of three planes.
Angle of a plane with the plane of co-ordinates - Angle of two planes. Conditions of parallelism and perpendicularity of two planes.
Straight line, equation of the straight line; equations of the straight line passing through one point and of the straight line passing through two points - Angle of a straight line with the axes - Angles formed by two straight lines; angle of a straight line with a plane - Distance from a point to a plane - Distance from a point to a straight line.

2. APPLIED PHYSICS

(1) Theory

2nd year

Mechanics

Revision and development of the chapters on mechanics given in general physics (1st year).

Forces:

Work of forces; graphical representation of the effect of forces - Work of a couple; deduction of its analytical expression; application exercises; rigid and flexible systems - Exterior and Interior motions; sum of the effects of the interior forces; deduction of their analytical expression - Central forces; effect of gravity; Work of forces applied to a system; work produced by a system - General expression of the elementary effect of the forces applied to a flexible and to a rigid system; measurement of the effect; units of measurement of the C.G.S. system, the Giorgi system, the practical system, the Metric system, etc; units of effect used in industry.

Power:

Notion of dynamic power; elementary power in the case of uniform effect and in the case of variable effect - Power of mechanisms - Distinction between force, effect of work and power. Power in the case of translatory motion, rotation, and helical motion; its analytical expressions - Units of power in the C.G.S. system, the Practical system, the Giorgi system, the Metric system and other usual units of power - Relations and equivalencies between the several units; equations of the dimensions of units. Application exercises; measurement of power; Prony's brake.

Quantity of motion:

Dynamic measurements of forces; impulse of force; theorem of the quantities of motion in the case of an elementary mass - Theorem of the quantities of motion of a system projected upon an axis; its deduction and discussion - Exercises and application problems.

Energy:

General notions of energy - Alteration or change of state of a system - Forms of mechanical energy; kinetic energy; potential energy - Their analytical expressions; deduction and interpretation.

Living force of a material point in motion - Living force of a body or a system in motion - Analogy with kinetic energy or living force of a solid in translatory motion - Kinetic energy or living force of a solid rotating around a fixed point or a fixed axis.

Moment of inertia: its analytical expression and its interpretation - Kinetic energy of a solid in arbitrary motion. Total mechanical energy.

Theorem of the living forces or theorem of the variation in kinetic energy when a system changes its position in space - Deduction and interpretation of this theorem; discussion of its analytical expression.
Work produced by the interior forces when a system is subject to a deformation; deduction of its analytical expression. Level surfaces - Equipotential surfaces - Potential energy of a material body.
Principle of the conservation of energy; deduction, interpretation and discussion of its analytical expression, considerating only forms of mechanical energy - Examples of modification of energy: Pendulum; vibrating elastic plate, etc.

Impossibility of perpetual motion - Principles of energy and of the motion in a conserving system.
Engines: Their classification; simple and complex engines; engines which change force and engines which change the form of energy - Principle of the transmission of work: Examples with the simple mechanical engines; levers; pulleys; tackles; inclined plane; windlass; screw; wedge, etc. - Kinetic energy of a flywheel of an engine - Efficiency of machines and engines - Principle of virtual effects. General notions.

Thermodynamics:

Elementary notions; objective of thermodynamics. General character of the methods of reasoning in thermodynamics - Mechanical effect; exchange of heat; various kinds of interchange between a system and the exterior medium - Special role of the temperature in thermodynamics; absolute temperature scale.
Transformation of a system; examples; geometrical representation of the states of a system; closed transformation cycles; Carnot's cycle - Work developed in a transformation; geometrical representation of the work; reversible transformation - Examples; isothermic transformation; adiabatic transformations - Examples.
Objective of thermodynamics in chemistry - The kinetic theory of matter and the dynamic theory of heat - Principle of the equivalency of heat and work; production of heat at the cost of work; heat may generate work and vice-versa. Experiments of Rumford and Tyndall.

Principle of the equivalency and its analytical expression; Interpretation and discussion of this expression - Necessity to consider the identity of the initial state and of the final state; closed transformation cycles - Hirn's experiment about lead subject to shock - Hirn's experiment about the steam engine - Experiments of Mayer, Joule, Carnot and other physicists - Mechanical equivalent of heat. Calorific equivalent of work. Generalization of the principle of the conservation of energy; interpretation and discussion of its analytical expression. Signification of the numerical value of the mechanical equivalent of the unit of heat - Closed transformations; not-closed transformations; interior energy: Examples - Measurement of the variations in interior energy by means of calorimetry - Chemical calorimetry - Consideration of the phenomena of change of state in accordance with the principles of conservation of energy and of equivalency.
Perfect gases; characteristic equations - Potential energy of perfect gases: Joule's law - Specific heat of gases. Relation between the specific heat of gases at constant volume and the mechanical equivalent of the calory - Direct demonstration of Mayer's formula.
Principle of the entropy or principle of Carnot-Clausius. (Second principle of thermodynamics) - Cycles with two heat sources - Thermic engine with two origins - Reversible transformations; non-reversible transformations - Reversible cycle with two origins (Carnot's cycle) - Efficiency of a thermic engine - Objective of the works of Carnot on thermic engines - Condition of maximum efficiency of a thermic engine - Efficiency of a reversible cycle with two origins (Carnot's theorem) - Thermodynamic temperature scale. Carnot's formula; its discussion.
Practical consequences of Carnot's principle or theorem - Absolute temperature; numerical expression of absolute temperatures by means of the properties of a fluid - Relation between the absolute temperature and the temperature reading on a perfect gas thermometer - Efficiency of a Carnot cycle in dependence of the absolute temperatures - Generalization of Carnot's theorem. Principle of entropy. Analytical traduction of Clausius' theorem: closed reversible cycles; closed realizable cycles; open reversible cycles; open realizable cycles, or partially realizable and partially reversible.
Non-compensated transformations - Characteristics of entropy; properties of entropy - Law of the entropy in the case of conservatory systems; discussion of the analytical expressions; the universe considered as a conservatory system.
Principal elements of a thermic engine - Calculation of the efficiency of a thermic engine - Economic efficiency and industrial efficiency - Comparison between a thermic engine and a hydraulic engine - Physical consequences of Carnot's

theorem - Heating and cooling at the cost of work. Carnot's cycle working in inversed sense - Refrigerating engines. Degradation of energy; its industrial importance - Various forms of energy and their transformations; their industrial importance.
Thermodynamic criterium of the chemical equilibrium in general - Chemical equilibrium in a homogeneous medium - Diluted solutions - Deduction of the law of the action of mass - Principle of the electrochemistry of diluted solutions- Phase rule and its applications - The problem of the chemical compound - Photochemistry; thermodynamical theory of photo-chemical reactions.

Vibratory motions:

Periodic motions; examples - Pendular motion, vibrating motion; oscillating motion; uniform circular motion projected upon a diameter. - General equations of periodic motions: their deduction and interpretation; graphical representation of these equations - Composition of two pendular motions in phase and with a phase difference. Fresnel's rule; phenomena of interference - Composition of a pendular motion and its various harmonics - Propagation of vibrating motions; longitudinal and transverse vibrations - Fundamental relation of the propagation of a vibrating motion - Superposition of direct waves and reflected waves - Stationary waves - Nodes and antinodes.

Acoustics:

Sources of sound and auditive sensations - Noise - Musical sound - Propagation of sound; velocity of sound in different media; intermediate means between the sources of sound and the ear.
Reflection of sound; echo, resonance - Laws of longitudinal and transverse vibrations - Qualities of auditive sensations: intensity; height; timbre.
Acoustic horn; acoustic tube; megaphone; microphone.
Limit of sensitiveness for sounds of various heights - Simple and complex sounds -Resonators; Helmholtz's resonator; sound analysis, synthesis of sound - Reversibility of sound phenomena - Phonographs - Gramophones.

Physical optics:

Light and its propagation - velocity of light; astronomical and physical methods as to its determination - Theory of ondulations - Propagation of light in vacuum.
Phenomena of interference; Fresnel's interference fringe - Hypothesis about the vibration of light; transverse vibrations; coloration of thin layers; Newton's rings -

Applications - Measurements of wave lengths.
Colour photography; Lippmann's method - Diffraction phenomena and their applications - Screens; use of screens; diffraction spectra.
Double refraction - Classic experiments as to the verification of this phenomenon - Experiments and constructions of Huyghens; common and extraordinary indexes.
Elementary notions of crystallography - Generalities about double refraction. Classification of crystallized double-refracting substances; their importance in crystallography - Theoretic interpretation of the phenomenon of double refraction; Fresnel's hypothesis.

Polarization:

Colourless polarization - Fundamental polarization experiment - Nicol's prisms - Plane of polarization. Recognizing a polarized ray of light; Polarisers; Analysers - Polarization by reflection and by refraction - Explication of the phenomenon of the polarization of light according to Fresnel - Interference of polarized beams of light - Chromatic polarization - Rotary polarization; its importance in analyses and its industrial importance: Applications; Polarimeters; Saccharimeter - Laboratory experiments on saccharimetry.

Radiant heat:

Reflection and refraction of radiant heat: Experiments of Rumford, Leslie and Melloni - Application of thermo-electric batteries - Study of a calorific beam - Absorption of heat; power of absorption - Interference of calorific beams. Fresnel's interference fringes - Polarization of heat - Identity of radiant heat and light.

Electricity and Magnetism

Static electricity:

Electrization and electric charge - Electrization by friction; electric attractions and repulsions; isolating bodies and conducting bodies; dielectrics; various ways to obtain electrization of bodies - Simultaneous development of the two forms of electrization.
Central newtonian forces - Analogy between gravitational mass, electric mass and magnetic mass; analytic representation of the central forces - The earth considered as a common container of electricity - Electrization is a measurable quantity.
Electroscopy - Measurement of electric charges - Coulomb's law about electric charges. Unit of charge of the electrostatic unit system (E.S.C.G.S.) - Practical unit of charge

of the electromagnetic system (Coulomb); its value in units of the electrostatic system - Systems of electric units: electrostatic system; electromagnetic system; electrodynamic system.
Distribution of the electrization in conductors - Superficial electric density - Volumetric density in bad conducting bodies.
Field of force; electrostatic field; definition of field; intensity of field; uniform field; field with an intensity equal to unity - Lines of force; tubes of force; equipotential surfaces.
Electric influence. (Electrostatic induction) - Electrization of a conductor by induction - Electrometric study of induction. Other ways of development of electrization in bodies - Principle of the conservation of electricity.
Electric potential. (Experimental notion of electric potential); potential of the infinite; earth potential; potential of a point of the electrostatic field; difference of potential between two points; characterization of the potential by its effect - Analytical expression of the difference of potential between two points: its deduction, interpretation and discussion - Characteristics of the potential function - Level surfaces and equipotential surfaces - Choice of the unit of potential; electrostatic unit; practical unit of the electro-magnetic system; volt - Value of the volt in units E.S.C.G.S.; flux of force; definition; elementary value of the flux, considering only one central mass; sign of the flux, unit of flux - Theorem of Green or of Gauss.
Electric capacity: Definition; experimental notion of electric capacity; analytical expression of capacity; choice of the unit of capacity; units of capacity of the electrostatic system and of the electromagnetic system: farad, microfarad.
Electric condensation: Condensers; principle of electric condensation - Condensing power of a condenser - Calculation of the capacity of a spheric, plane or arbitrarily formed conductor - Series and parallel connection of condensers; applications of condensers - Electroscope condenser of Volta.
Electric energy: Its analytical expressions - Electric effect; its expression - Actual energy, potential energy - Definition and calculation of the potential energy of a condenser - Calculation of the discharge energy of a condenser or of a conductor.
Electric machines - Friction machines - Induction machines - Definition and principal elements of electrostatic machines - Use of electrostatic machines.

Magnetism:

Magnets - Magnetization of iron; distribution of the magnetic properties in a magnet; natural and artificial magnets - coercitive force.
Poles; orientation of the poles of a magnet - Compass - Mutual action of magnets: Qualitative and quantitative laws - Definition of magnetic masses - Mass unit - Coulomb's law about magnetic attractions - Magnetic field; sense of the field; unit of intensity of the magnet field; force lines; magnetic flux; unit of flux.
Earth field; action of the earth field.
Central forces - Analogy between the gravitational field, the electric field and the magnetic field - Magnetic moment of magnet - Moment of the directive couple - Constitution of magnets; Weber's hypothesis; magnetic filament; magnetic shell.
Magnetic density of an elementary magnet-pole; intensity of magnetization. Dimensions of the units of magnetic mass, of field intensity of magnetic density, of magnetic moment, of intensity of magnetization - Astatic systems. Experiments of Galvani and Volta; Volta's principle; law of the successive contacts; Volta's pile.
Classification of hydroelectric primary batteries; polarisation of batteries; Connection of batteries - Experiments showing the transformation of chemical energy into electric energy - Properties of electric current; sense of the current; magnitude or intensity of the current - Analogy between current and a succession of electric discharges - Units of intensity of current; practical unit of intensity: ampere - Electromotive force of a battery - Comparison between the battery and the electrostatic machine considered as source of energy.
Ohm's law. Electric state of a conducting wire through which a current is passing - Theory of Ohm. First law of Ohm. Second law of Ohm (about resistance). - Resistivity or specific resistance - Units of resistance; practical unit, ohm. Standard ohm - Specific conductibility; conductance.
Electromotive force of a battery in an open circuit and in a closed circuit - Resistance boxes; resistance of a group of conductors - Laws of Kirchhoff; rheostat; shunt, bridge of Wheatstone.
Efficiency of a battery; maximum current to be obtained by the choice between various ways of connecting the elements of a battery.

Heat and light generated by electric current:

Joule's experiments; Joule's law; energy of the current. (Joule effect); unit of energy - Power of the current; units of electric power - Electric illumination; incandescent lamps; arc lamps - Electric heating - Production of high temperatures - Electric furnace; industrial applications - Electrometallurgy - Thermoelectricity - Experiment of Seebeck - Thermoelectric batteries; applications - Thermoelectric pyrometer; reversibility of the thermoelectric phenomena.

Chemical action of the electric current:

Electrolysis - Qualitative and quantitative laws of Faraday - Theories about electrolysis; theory of Arrhenius - Strong electrolytes; weak electrolytes - Applications of the chemical actions of the electric current - Unit of intensity of the electric current - Practical definition in electrolysis of the coulomb and of the ampere - Use of the chemical actions of the electric current in the chemical industry: Galvanization; galvanoplastics; electrometallurgy.
Storage batteries: Accumulators; principle of the accumulator; Accumulator of Planté; quick charging accumulators - Source of energy in the battery; polarization - Comparison between lead and nickel accumulators - Efficiency of accumulators: quantity and energy; use of accumulators.

Magnetic influence of the electric current:

Experiment of Oersted; influence of a current on a movable magnet - Experiment of Larive: a magnet influences a movable conductor carrying a current - Magnetic field of a current; form and sense of the force lines; classic experiments.
Qualitative law of the magnetic action - Quantitative law of Laplace; experimental verification.
Solenoids; intensity of the magnetic field inside the solenoid - Ammeters and voltmeters.
Electromagnetic unit of intensity of current; dimensions of the units of intensity of current and of quantity in the electromagnetic system - Tangent and sinus galvanometer.

Electrodynamics:

Laws of the electrodynamic influences: Ampere's laws; law of the parallel currents; law of the crossing currents; law of the curved currents.
Theory of Ampere; equivalency of a closed current and a magnetic shell - Electrodynamic influences: Influences of a rectilinear current on a movable solenoid; Influence of a fixed solenoid on a movable solenoid; analogies of solenoids and magnets - Electromagnets: Applications; principle of the electric telegraph.

Revision of the fundamental laws and the formulae of electricity - Units of the electromagnetic system; practical units: their definitions and deductions of the dimension equations, multiples and submultiples of the practical units.

Electric induction:

The discovery of induction phenomena and the development caused by this discovery in the practical applications of electricity - Fundamental experiments of Faraday; Faraday's laws about induction: induction by currents; induction by magnets; induction by the earth; self-induction.
General laws about induction phenomena - Notion of flux through a closed contour; expression of flux through a plane contour - General law concerning the cause and the duration of the induction phenomenon - General law concerning the sense of the inducted currents, or law of Lenz - Quantity of induced electricity; induced electromotive force; intensity of the induced current - Induction coil of Ruhmkorff and its applications - Principle of the magneto-electric and dynamo-electric machines.

Electric waves:

General notion about electric waves; hypothesis of Maxwell; experiments of Feddersen; experiments of Hertz; resonator of Hertz - Maxwell's electromagnetic theory of light.
Practical applications of electric waves: Wireless telegraphy. Oscillating discharge - Production of high frequency currents; high tension; effects and applications of high frequency currents - Electric discharges in rarefied gases; cathodic rays - Crookes' tube - Notable properties of cathodic rays - X-rays: their properties; notable applications; measurement of the radiation of X-rays.
Radioactive bodies; Radium - Experiments of Becquerel and of Curie - Characteristic phenomena of radioactivity; radioactivity considered as an atomic property: experiments - Emanation of radium: radon; measurement of emanations; unit of measurement: Curie - Atomic disintegration; radioactive constant and half duration.
Hypotheses about the nature of electricity considered as a form of energy; hypotheses of Franklin, Arrhenius, Faraday, Maxwell and Hertz - Actual interpretation of the phenomena of radioactivity and of the constitution of atoms; ions, electrons, protons, neutrons, etc. - Conception of Rutherford, Bohr, Joliot-Curie, Perrin, etc.
Photoelectricity; photoelectric effect, photoelectric cell; its development and applications.
Practical and industrial electric units.

Elements of meteorology - atmospheric phenomena:

Climatology; air temperature; climates; influence of latitude and altitude; isothermics; micro-climates. Cause of winds; various kinds of winds: regular winds, periodic winds, irregular winds - Wind velocities: their classification.
Atmospheric humidity; hygrometry; hygrometric states; hygrometers.
Atmospheric electricity; atmospheric electric fields; electrization of clouds; tempests; lightning; flash of lighting; thunder; effects of lightning - Lightning-arresters; lightning conductors of Franklin and of Melsens. Earth magnetism, magnetic field of the earth; magnetic inclination and declination; inclination and declination compasses.

(b) Laboratory work 2nd year

Effect of forces: Problems: Osmose: Osmotic pressure; isotonic solutions; osmometer: Application to the determination of the molecular weight of soluble substances; viscosity - Liquid discharge at constant speed. Mariotte's vessel.
Elasticity: Laws of Hooke; experimental study of elasticity; determination of the elastic modulus elasticity problems connected with tensile stress and compressive stress.
Mariotte's law: Problems - Laws of Charles and Gay-Lussac about gases: Problems - Laws of perfect gases: Problems - Density of gases; method of Regnault; effusion-meter of Bunsen - Density of vapours: limit density; methods of Gay-Lussac and Meyer for the determination of the density of vapours - Specific heat of gases; their laws - Gas mixtures: laws of Bertholet-Dalton.
Real and apparent dilatation of liquids; relation between the respective coefficients; determination of the coefficient of real dilatation of mercury.
Determination of: the fusion point of a substance; the point of solidification; the boiling point of a liquid; the heat of fusion; the heat of vaporization - Calorimeter of Bertholet - Determination of the heat of combustion; calorimeter of Mahler.
Atomic heat: laws of Dulong and Petit; superfusion; oversaturation - Lowering of the freezing point by the dissolved substances - Cryoscopy: Laws; application to the determination of molecular weights - Raising of the boiling point by dissolved substances - Ebulliscopy; laws and their application.
Dissolution: coefficient of solubility; concentration; analogy of the properties of diluted solutions and of gases - Influence of pressure on the point of fusion; freezing - Influence of pressure on the boiling point; autoclaves; Psychrometer of August - Hygrometer of Regnault and of Allouart.

Thermodynamics: Tyndall's experiment - Equivalence of units of heat and units of work - Determination of the mechanical equivalence of heat - Moine's experiment.

Equivalence of Mayer's principle: Problems - Isothermic and adiabatic transformations - Carnot's principle; efficiency. Problems - Absolute temperature scale.

Steam engine; its elements and working - Calefaction: Laws; explosion of steam boilers.

Vibrations: periodic motion; composition of motions with the same period, in phase and out of phase - Wave length; longitudinal and transverse vibrations - Interference; Fresnel's interference fringes - Determination of the wave length of a source of light - Principle of enveloping waves.

Lenses: Achromatic lenses; prisms - Calorific, chemical and luminous spectra - Study of the spectroscope; direct spectroscopy; emission and absorption spectra; elements of spectral analysis - Study of the microscope; amplification of the magnifying glass and of the microscope - Dark room; real dimensions of the object.

Photometry: Determination of the intensity of light; laws of Kepler and of Lambert; photometric units of light; double refraction - Polarization of light: Nichol's prisms; fundamental experiment on polarization; polarization by reflection, by refraction and by double refraction; rotary polarization; laws of Biot; generalities about rotary polarization; Saccharimeter of Biot; shade saccharimeter of Laurent; determination of the concentration and of the degree of purity of sugar solutions.

Electricity: Electric and magnetic field; Coulomb's laws; Problems - Condensers: Standard condensers; units of capacity; problems - Nature of magnetism: analogies and differences between the phenomena of magnetism and electrization; analogy of solenoids and magnets - Ampere's theory of magnetism: Study of magnetic fields; mutual influences of the poles of a magnet; their laws. Unit of magnetic mass; problems - Earth magnetism: declination and inclination compasses - Static needles: Field intensity; magnetic flux; units of field intensity and of magnetic flux.

Illustrative experiments about the various effects of the electric current: sense of the current; intensity and electromotive force; units and problems - Calorific effect of the electric current: Joule's law; energy and power of the electric current; problems - Chemical actions of the electric current: Electrolysis; laws of Faraday; copper sulphate voltameter; galvanization - Batteries: Connections of batteries; problems; standards of electromotive force - Magnetic effects of the electric current: Experiment of Oersted; Ampere's rule; electromagnets; electric bell; drop of potential along a conductor.

Laws of Ohm: unit of resistance; resistance standards; problems - Factors that affect the resistance of a conductor; Temperature; self-induction; capacity - Study of the bridge of Wheatstone: Measurement of a resistance; laws of resistances in series and in parallel; shunts.
Study of measuring instruments: Galvanometers; ammeters; voltmeters; wattmeters - Calibration of a voltmeter and of an ammeter.
Inducted currents: Induction by currents, by magnets and by electromagnets; laws of Faraday; laws of Lenz; self-induction - Study of the ideal dynamo: Ways of excitation; reversibility; resistance, inductance and capacity in an alternating current circuit - Power in an alternating current circuit: Ruhmkorff's coil; principle of transformators - Geissler's tubes: Cathodic radiation; x-rays; their properties and applications.

3. GENERAL AND APPLIED HYDRAULICS

(a) Theory

1st year

General hydraulics:

Introduction

Hydrostatics:

Perfect fluids and natural fluids - Mass, density and specific weight - Units.
Pressure in a point; effective pressure and absolute pressure; units - Direction of the pressure in relation with the element under pressure - Equality of pressure around a point - Pascal's principle and its practical applications.
General equation of hydrostatics; level surfaces; study of the variation in pressure in a liquid in rest; communicating vessels and superposed liquids - Specific pressure and total pressure or impulse - Piezometric height and plane of hydrostatic pressure head.
Atmospheric pressure; representative height of pressure; units - Triangle of pressures or of impulse - Centre of pressure and total pressures on plane and curved surfaces; analytical and geometrical processes for their determination, general formulae considering an inclined trapezium and referring to depths or distances; position of the centres of pressure in relation with the centres of gravity - Zones of equal pressure: graphical and analytical processes; sluice valves; dam-needles; stability of a dam; tanks and boilers.
Thickness of tubes (calculation); reference to commercial catalogues - Valve gates of constant level, sluice gates and lock gates.
Archimede's principle; equilibrium and stability of immersed and floating bodies; indication of some practical applications - Effect of the environment on a deformable body - Relative equilibrium of fluids in vessels in rotary motion (horizontal axis and vertical axis); practical applications in turbinology, foundations, speed indicators, etc.

Hydrodynamics:

Permanent motion and variable motion; their characteristics; parallelism of sections.
Principle of continuity; discharge or delivery - Rate of pressures in liquids in motion; static pressure and dynamic pressure.
Bernoulli's theorem; statement and graphical representation - Pressure plane, static and effective pressure lines - Line

of piezometric levels and pressure head between two points - Losses of pressure and concise indication of some of their causes, introduction of losses of pressure in Bernoulli's equation - Generalization of Bernoulli's theorem as to relative motion.

Flow through orifices:

Indications of the various devices used in practice and their purposes - Contraction of a vein of liquid; complete and incomplete contraction - Coefficients of velocity, of contraction and of delivery - Theoretical and effective delivery. Delivery under constant pressure: (i) Complete orifices (as to their forms, dimensions, situation and pressure); sluice valves and discharging chutes; delivery under pressure; (ii) Weirs (as to their profiles and position, nature of the layer of liquid, and pressure); (iii) Additional tubes: Theorem of Belanger; pressure losses because of variations in section; practical applications and devices in pipe work.
Tables of delivery coefficients - Delivery through complete orifices under variable pressure: variable cross-section; constant cross-section; feeding discharge.

Flow of water in tubes:

Navier's hypothese; mean velocity - Friction in liquids; laws and general expression of friction - Fundamental equation of the flow in tubes with constant diameter - Pressure and loss of pressure - Practical formulae: tables and nomograms for their application - Influence of diameter and pressure on the discharge - Influence of a variation in diameter on the pressure (economic conditions for the installation of a pumping station) - Losses in singular points of a pipe-line (changes in cross-section, changes in direction and various devices) - Study of a simple pipe with constant diameter and discharge - Tube feeded by one or two tanks; flow at the ends and flow along the tube; equivalent discharge.
Limit of velocity in pipes; most economical diameter and velocity in the case of a pump discharge pipe - Power of a pumping station; shunting pipe - Mixed pipes; dominant importance of the pipe section with the smallest cross-section on the delivery - Complex pipes; necessity of their application - Equivalent pipes; advantages and economy as a result of their use - water hammer in pipe-lines - Spring wells; syphons.

Water distribution:

Previous study and data required; distribution system - Laying-out; situation of tanks - Deliveries to be realized and localization of the various points of feeding -

Calculation of the diameters; most economic solution - Mean velocities in the various pipe sections - Available pressures in each point - Pressure lines and longitudinal profiles - Filling in of a water distribution table - Elements of which a distribution project consists - Precautions to take before putting a piping system under pressure.

Flow of water in channels:

Variation of velocity in a cross-section; maximum velocity, velocity at the bottom and mean velocity - Uniform and variable rate of flow - Equation of motion for the uniform rate of flow.
Practical formulae; tables and nomograms for their applications - Principal factors which have influence upon the cost of a canal; usual cross-sections and their characteristics - Limits of the mean velocity and of the slope - Average radius of the various cross-sections; most advantageous forms for a cross-section; trapezium of maximum discharge - Diversion channel - Cross-sections of aqueducts and sewers; levels corresponding to maximum delivery and maximum velocity - Hydraulic jump and recoil; back water curves.

Evaluation of discharges:

Hydrographic, hydrometric and tachometric operations in water streams - Direct measurement of small discharges (sources) - Flow-meters for pipe-lines and tubes; Venturi meters - Measurement by means of complete orifices and weirs (rivulets and small brooks) - Measurement near a dam - Determination of the cross-sectional area of a water stream; study of the variations of the velocity in a cross-section; formulae and tables.
Measurement of velocities: Floats; tube of Pitot; tube of Darcy; double or compound float; dynamometer or tachometer of Brunings; hydrometric propellers; Woltmann and Ott Kempton; ballasted rod.
Evaluation of discharges by means of the method of salt solutions - Calculation of the discharge by means of the mean velocity of the cross-section, according to the methods of Harlacher or of Culmann - Calculation of the discharge when the longitudinal profile and various transverse profiles of the water stream are known - Discharge scales, total volume of flow and mean volume of flow - Empirical formulae for the evaluation of volumes of flow of water streams.

Urban hydraulics 2nd year

Water supply:

Hydrogeology; utility of these studies - Origin of subterranean waters: rain - Pluviometry: pluviometric observations - Average yearly rainfall; maximum and minimum yearly rainfall; average monthly rainfall; intensity; frequence and probability of rain; lines of equal average yearly rainfall and the way of drawing them - Fractions of rainfall: evaporation, flow and infiltration.
Permeable and impermeable soils; porosity and permeability; direct and indirect permeability; measurement of the porosity - Process of infiltration; upper ground water level; artesian formation - Classification of wells: natural springs, wells, and veinous or rock springs - Appearances and reappearances.
Quality of the water of aquiferous nappes and of wells - Power of aquiferous nappes and discharge of wells - Investigation of wells and of aquiferous nappes - Study of the aquiferous reserves.
Notions about the theory of subterranean flow - Experiment of Darcy; Dupuit's formula - Aquiferous nappe in a horizontal plane, in an inclined plane - Filtering gallery in a horizontal plane - Filtering well in a horizontal nappe - Artesian wells: Nourtier's theory - Examples of practical applications.

Urban sanitation:

Utilization and indispensability of water - Drinkable water: its qualities; sampling and analysis - Purification of water: decanting, filtration and sterilization - Necessary water quantities to be delivered: variations in consumption - Catchment of water: wells, tanks and deposits; rivers, streams, lakes; diversions: storage basins; wells, filtering galleries and mines - Tanks and deposits; pumping of water. Water mains from the catchment on - Construction works (arches, bridges, syphons, tunnels and accessory works, sky-lights, conduit pits, ventilators, etc.) - Various materials, apparatus and devices used in piping - Urban distributions; various systems; tests of a piping system. Supply and sale of water to the consumer; water meters and their calibration - Public water supply (fountains, watering places, drinking fountains, bath houses, latrines, fire cocks, water taps for spraying and cleaning purposes, decorative spring fountains) - Distribution in public and private buildings - Maintenance of water distribution systems - The water supply to the cities of Lisbon and Oporto.

Sewers:

Matters to be drained off; classification and quantity - Indispensability of sewers for urban sanitation - Sewerage systems, collectors, tanks and draining channels - Mixed circulating system: "everything to the sewer": - Refuse waters and atmospheric waters; laying-out - sections - calculations.
Separated circulating systems (liquids separated):
Velocity and slope; laying-out and sections; materials in the circulating refuse waters; calculation of the piping system; drainage of the clear waters.
Installation of the mains - Dividing into separated sections by valves and syphons - Inspection and cleaning pits - Execution of the service - Sewers of residences; various devices: syphons, surface boxes, valves, etc. - Ventilation; cleaning; flushing cisterns - Destination of sewerage water; sink ditches - Purification and use of refuse - Pneumatic sewers - The sewers of Lisbon and Oporto.

Agricultural hydraulics

Generalities:

Agriculture and climate - The soil: physical and chemical properties; categories of soils - Plant life: consumption of water for their constitution and compensation of evaporation (transpiration) - Fertilizing substances in suspension or dissolution in water - Drainage and drying, stoppages and desalinations.

Drainage:

Origin of the excess water; inconvenients - Theory of drainage; effects of drainage; installations of a drainage system; longitudinal and transverse drainage - Depth of drains and interval between them - Slopes, diameters and discharge of drains and collectors - Drained area; laying-out and length of drains - Calculation of draining channels - Execution of a drainage; various devices - Maintenance - Absorption pits - Drying ditches (open and closed).
Irrigation, stoppages and desalinations:
Objects of irrigation, of stoppages and of desalinations; advantages - Fertilizing action, of irrigation of the soil and of heating - Qualities of the waters to be used - Irrigation periods; water quantities for each irrigation and for each irrigation period; deliveries; practical data.
Catchment of water; branches with and without dam - Irrigation methods, soil provisions; distributing and collecting system: flow; inundation; submersion;

infiltration; spraying - Choice of the method to be adopted - Execution of the work - Irrigation with special objects - Irrigation works in Portugal - Utility of stoppages: usable waters - Methods of stoppage (continuous and intermittent) - Maintenance of irrigation and stoppage works - Desalination of soils; valuation.

Rivers and seaports

Irrigable rivers:

Classification - Elements of a stream of water; carrying-away force; carrying away of materials - Form of the river-bed in horizontal plan; transverse and longitudinal profile - Stability of the bed - Relation between the form of the banks and the bottom relief - Soundings; measurement of the depths and their graphical representation.

Works to improve and establish navigation:

Freely streaming rivers - Improvement works - Towing ways - Protection of the banks; protection systems: stone linings; timber linings - Sheathings and foundations - Regularization and improvement of the riverbed; dredging; stop page of secondary arms - Method of regularization by narrowing the bed.

River ports:

Wooden, reinforced concrete and masonry quays. Accessory works.

Canalized rivers:

Permanent weirs; weir profile - Sluices and sluice doors - Moveable sector, stop-plank and drum weirs - Constitution of a moveable weir - Spacing of weirs.

Canals:

General consideration and classification - Side canals and dividing canal systems - Canal crossings with other ways of communication - Water consumption on canals; water supply - Means to reduce the water consumption - Supply reservoirs - Inclined planes; elevators; canal sluices.

Sea harbours:

Tidal movements: waves, tides and tidal currents; theory of the tidal movements; tidal recorders - Localization of the harbour - Coastal characteristics - Ports and bays.

Classification and general disposition - Exterior harbour works; outports; floating docks - Sea sluices; tidal docks; wall quays - Installations for construction and repair of ships; Shipbuilding and repair yards; elevating apparatus.
Means of protection against the sanding up of harbours; natural influences - Erosive currents; dredging - Beaconage of the coasts; lighthouses.

(b) Practical course in hydraulics(1) 1st year

Determination of the total pressure and the centres of pressure on surfaces - Application to weirs, dams, reservoirs, etc., to obtain the necessary data for strength calculations to be executed in other subjects of the course - Calculation of deliveries through orifices, weirs and pipes in cases of practical application - Calculation of the time of discharge of a storage basin with or without a feeding stream (variable pressure) - Determination of losses of pressure - Solution of problems of flow in water pipes and distribution systems, channels, aqueducts and sewers - Laying-out of the line of piezometric levels in a section of a distribution system - Practice in interpolation of discharge coefficient tables and in reading of graphs and nomograms in order to resolve various problems - Reference to hydraulics handbooks, textbooks and catalogues.

2nd year

Simple applications to improve theoretical and practical knowledge - Comparison of various cross sections of sewers and choice of the most adequate type - Calculation of a small water distribution pipe system, furnishing the project with all the necessary accessories - Calculation of the discharge measurement of a water stream - Reference to handbooks, textbooks, catalogues and technical literature necessary for the execution of the practical exercises to be done.

Study visits and excursions:

Water supply of Lisbon: storage basin of Amoreiras; the free water aqueduct and storage basin of Barbadinhos; Water catchment by wells in Carregado; the general office of the Water Supply Company of Lisbon in order to study the general water catchment plan, the transportation and distribution of the water to the city.
Municipal works: study of the maps concerning the city's sewerage systems.

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(1) The development and number of practical exercises is organized in accordance with the time available during the academic year. Every student keeps a record of his practical exercises which is centrally filed by the administration of the hydraulics course.

Excursion at the end of the course in order to look at the principal hydraulic works of the country already completed or under construction, as well as the water catchment and sanitation services of the city of Oporto (pneumatic sewers). Dams of hydro-electric power stations, irrigation dams, etc.

4. TOPOGRAPHY (THEORY)

Fundamental notions:

Definitions: Topography; Planimetry; Photogrammetry, aereal and terrestrial; Mine surveying; Altimetry; Limit of topographic maps - Scales; charts, maps - Conventional signs.
Representation of terrestrial elevations:
Measured points: methods; problems - Contour lines: methods; problems - Normals.

Reading and use of maps:

Measurement of distances on maps, Measuring instruments: Compilometer of Goumet, Dial curvometer; roulette of Depuit - Measurements of areas on maps: analytical methods; mechanical methods; plimeter - Practical exercises in map reading; Reading of a map without comparing it with the terrain; reading of the map being on the terrain - Relations between planimetry and levelling; Brisson's laws - Drawing and reproduction of maps; Pantograph.
Orientation: orientation by the compass; by means of the map; by the stars; by means of indications and informations.

Planimetry:

Methods of surveying: method of the co-ordinates or of the normals; polygonal method, or method of measuring; radiation method, or method of polar co-ordinates; method of intersection; method of isolated points or of Pothenot; method of alignments; method of triangulation; photographic method; combination of fundamental methods - Measurement of distances on the terrain: alignments; direct measurement of distances; indirect measurement of distances; level-rods, sighting-boards and topographic telescopes; telemeters - Measurement of angles: surveyor's cross; goniometers, planimeter, graphometer, sextant; types of compasses, alignment circle and geodesic circle; goniograph, sight board, sight rule and accessories; use of sight board and sight rule - Practical surveying exercise.

Altimetry:

Levelling processes: direct levelling; models of field-books - indirect levelling; models of field-books - barometric levelling - Surface and contour line; real and apparent level - Causes of errors in levelling.

Instruments used in levelling: water-level; target staff; builder's level; spirit-level, tubular and spherical; their calibration and corrections - Surveyor's level; types of levels; examination and correction of surveyor's levels; collimator level; clinometer of Chezy - Practical levelling exercise.

Planimetric and levelling instruments:

Self-reducing alidade of Paigne; theory of self-reduction - Theodolites: description of the instrument; working conditions of the theodolite for the measurement of angles; correction of theodolites; theodolite with eccentric telescope; error of eccentricity of the index scales of theodolites; repetition and reiteration method; method of the crossed observations, theodolite of Wild - Transit theodolite; its correction, calibration and use - Self-reducing transit theodolite.

Photogrammetry:

Terrestrial photogrammetry - Apparatus used in photogrammetry: Photographic cameras; photo-theodolites; plotter of Roussilhe; stereo-photogrammetric apparatus.

Mining topography:

Special apparatus used in mining topography: Mining compass; theodolite; luminous targets.

Execution of surveying. Topographic calculations:

Topographic triangulation: choice and number of points; form of the triangles; graph or preliminary scheme of the triangulation; measurement of the bases; measurement of the angles; reduction of the directions to the measuring centres; closing of the triangles; calculation of the triangles; determination of the azimuths of the sides of the triangles; calculation of the Cartesian co-ordinates of the vertices of the triangles; calculation of the azimuths and of the distances by means of the co-ordinates.

Polygonal surveying: measurement of the lengths of the sides and measurement of the angles; calculation of the polygons; compensation of the polygons; graphical compensation; polygons based upon triangulation.

Other methods of surveying: Radiation method - Method of the normals - Method of the intersections - Sectional method - Alignment method - Method of the metric measurements.

Hydrographic levelling.

Topography (Practical)

(Civil engineering and mining course) 2nd year

A - Exercises in map reading: Instruments used; knowledge of the conventional signs representing the form of the terrain and of all details of planimetry and levelling; examination of the simple and complex natural forms of the terrain, and of the relations between planimetry and levelling; estimation of areas on the map. Use of the planimeter; exercise in reading of terrain elevations on the map; complete description of a patch of ground represented on the map.

B - Use of the pantograph: Orientation exercises - Direct determination of distances - Indirect determination of distances. Use of level-rods - Exercise in angle measuring with goniometers and goniographs - Exercises with levelling instruments - Use of the theodolite, the transit theodolite and the self-reducing alidade - Correction of surveyor's level, theodolite and transit theodolite - Levelling of a polygon or a profile, with the surveyor's level, and afterwards, making a drawing of it - Execution, in the field, of a levelling with the side board, the surveyor's compass, theodolite and transit theodolite, and execution of the respective map.

APPENDIX IV

SELECTED LIST OF INDIVIDUALS AND ORGANISATIONS CONSULTED

1. Technical Commission for Economic External Co-operation

   Commissão Técnica de Cooperação Económica Externa - (Mr. Duvens, Secretary, Mr. Sousa de Macedo).

2. Ministry of National Education

   (i) Office of Educational Research and Planning - Gabinete de Estudos e Planeamento da Acção Educativa - (Mr. Pessoa Jorge, president; Mr. Prostes da Fonseca, Director MRP; Mr. Alambre dos Santos, Director).

   (ii) Institute of Professional Orientation (Prof. Dr. Oliveira Guimarães, Director).

   (iii) Director General of Technical and Professional Education (Dr. Carlos Proença).

   (iv) Inspector of Agricultural Education (Eng. Mario Alegria).

3. Ministry of Corporations (Labour)

   Foundation for Manpower Development - Fundo do Desenvolvimento de Mão de Obra - (Dr. Cruz Rodrigues, Director).

4. National Institutions and Commissions

   (i) Comissário do Turismo (Mr. Reis and other officials).

   (ii) Instituto Nacional de Investigação Industrial (Eng. Magalhães Ramalho, Director).

   (iii) Instituto Nacional de Estatística.

5. Schools and Institutes

   (i) Instituto Superior Técnico (Dr. Almeida Alves, Principal).

   (ii) Instituto Industrial, Lisboa (Eng. Geada, Principal).

   (iii) Escola industrial Marquês de Pombal.

(iv) Escolas Comerciais Oliviera Martins.

(v) Escola Elementar Francisco Arruda.

6. Professional associations - Industry

(i) Associação Indústria Portuguesa (Eng. Carlos Alves).

(ii) Corporação da Indústria (Dr. António Augusto de Aguiro and other members of the council).

(iii) Ordem dos Engenheiros (Eng. Fernando Pessoa, vice president).

(iv) Sindicato dos Engenheiros Auxiliares, Agentes Técnicos e Condutores (several members of the council).

(v) Gas and Electricity Company, Lisbon (Mr. Paiva e Pona, Chief Manager).

(vi) LISNAVE, ship-building industry (Mr. Costa André, Technical manager).

(vii) SOREFAME, Metal industry (Eng. Luciano de Oliveira Faria, director of industrial relations; Eng. Fontes dos Santos, in charge of training).

(viii) Standard Electric (Mr. Carvalho Fernandes, managing director; Mr. Fernando Calado, personnel manager).

Appendix V

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Appendix VI

STATISTICAL ANNEX

A. Finance

B. Education

C. Population and manpower

A. FINANCE

National Income and G.N.P.

Table VI-1

Since 1955 the Portuguese economy has been expanding constantly, with Gross National Product rising at an average annual rate of about 8.3 per cent at current prices of 6.2 per cent at constant 1958 prices. The annual net income of the Portuguese people amounted to escudos(1) 82,365 millions in 1964; compared with 1955, national income has nearly doubled. Per capita Gross National Product reached in 1964 Esc. 9,600 (corresponding to U.S. $320).

Table VI-2

The contribution of the main productive sectors to G.N.P. for the years 1954, 1958, 1960 and 1964 are given in this table. The importance of the secondary sector has been constantly growing since 1955, owing to increased activity in manufacturing and construction. During the same period the contribution of agriculture to Gross National Product dropped by some 9 per cent while that of the other branches remained constant or showed slight variation.

Industry

Table VI-3

This table gives an analysis of the industrial structure of the country for the years 1958 and 1964. Portugal is constantly developing industrially, although the rate of industrialisation is not particularly high. During the period 1958-1964 production increased by some 40 per cent at current prices or 35 per cent at constant 1958 prices, while total employment in industry went up by only 8 per cent. At present, the most important industries are food and beverages and the manufacture of textile and other clothing materials.

Foreign trade

Tables VI-4 and VI-5

Even though most of the large industrial firms produce mainly for export, imports in terms of value surpass exports considerably. During the period 1955-64, the value of exports amounted to an average of 21.3 per cent of G.N.P. while that of imports reached 27.3 per cent of G.N.P. The percentage of imports covered by exports rose sharply to 87 in 1964 as compared with 77 in the previous year and 81 in 1955. The main goods imported and exported in 1964 are given in Table VI-5 as a percentage of total imports and exports respectively.

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(1) One U.S. dollar = 30 escudos.

Expenditure for education

Tables VI-6, VI-7 and VI-8

Public expenditure for education amounted to a thousand million escudos in 1958 and to escudos 1,271.6 million in 1963. An average of 17 per cent of the 1958-1963 expenditure was spent in capital investment, the rest being taken up by current expenditure. Expressed as a percentage of G.N.P. expenditure for education remained practically constant during the period 1958-1963 (1.79 in 1963 as compared with 1.76 in 1958), while as a percentage of net income it dropped from 1.86 in 1958 to 1.72 in 1963. The distribution of expenditure by level and type of education (Table VI) shows that, after primary education, secondary, technical and other vocational education enjoy the biggest share. Further analysis of investment in buildings, by level and type of education, is given in Table VI-8.

Table VI-1

National Income and Gross National Product at factor cost (selected years, 1955-1964)

in million escudos

Year	National Income at current prices	G.N.P. at current prices	Index (1958 = 100) current prices	Index (1958 = 100) constant prices
1955	44,413	47,227	86	91
1958	51,815	54,988	100	100
1960	60,345	64,137	117	114
1962	69,131	73,494	134	129
1963	74,407	79,271	144	136
1964	82,365	87,758	160	147

Source: Instituto Nacional de Estatística (INE) - Anuários Estatísticos)

Table VI-2

Percentage contribution of the productive sectors to G.N.P. (selected years, 1955-1964)

Sector	1955	1958	1960	1962	1964
Primary	30.1	26.9	25.7	23.8	20.7
Agriculture	28.6	25.7	24.2	22.7	19.4
Fishing	1.5	1.2	1.5	1.1	1.3
Secondary	37.4	40.1	41.2	41.7	44.6
Mining	1.2	0.7	0.7	0.5	0.7
Manufacturing and construction	34.3	37.0	37.9	38.6	41.5
Gas, electricity, water and sewerage	1.9	2.4	2.6	2.6	2.4
Tertiary	32.5	33.0	33.1	34.5	34.7
Transport and communications	5.5	5.6	5.3	5.4	5.7
Commerce	7.8	7.8	7.2	7.2	7.4
Finance, insurance real estates	5.2	5.7	5.9	5.9	6.7
Public administration and defence	5.2	5.0	5.4	7.3	6.7
Education and services	2.0	2.1	2.6	2.8	2.7
Other services	6.8	6.8	6.7	5.9	5.5
	100.0	100.0	100.0	100.0	100.0

Source: INE (Anuários Estatísticos)

Table VI-3

Industrial establishments(1) (1958, 1964)

Type of industry	Number of establishments		Production in millions of current esc.		Total employed	
	1958	1964	1958	1964	1958	1964
1. Mining, quarrying	829	743	433.5	594.9	25,070	19,040
2. Food beverages, tobacco	1,960	3,002	6,337.7(2)	9,247.6(2)	41.851	40,202
3. Textiles, clothing	1,536	916	4,395.6	6,837.9(3)	100,322	100,011
4. Wood and cork products(4)	915	966	2,377.8	4,890.4	26,551	30,525
5. Leather, rubber	385	348	768.7	1,816.6	6,533	8,993
6. Chemical products	644	500	2,707.3	3,491.7	11,144	11,003
7. Non metallic mineral products	380	539	1,336.5	3,322.4	26,773	33,820
8. Basic metallurgy, machinery and transport equipment and construction	193	222	1,683.3	3,767.6	20,906	27,029
9. Other	136	225	194.3	273.5	3,643	7,311
Totals	6,978	7,461	20,234.7	33,242.6	262,793	277,934

(1) Excluding gas and electricity production.
(2) Excluding mineral and table water industry.
(3) 1962 figures plus 20 per cent.
(4) Excluding furniture.

Source: INE (Anuários Estatísticos, 1958, 1964).

Table VI-4

Foreign Trade and its relation to G.N.P.

(selected years, 1955-1964)

Year	Imports of goods and services million esc. at current prices	% of G.N.P.	Exports of goods and services million esc. at current prices	% of G.N.P.	Percentage of imports covered by exports
1955	12,255	26	9,972	21	81
1958	14,681	27	11,311	21	77
1960	16,724	26	12,282	19	74
1962	19,268	26	15,062	20	78
1963	21,606	27	16,681	21	77
1964	28,516	32	24,939	26	87

Source: National Accounts Statistics - O.E.C.D. 1966

Table VI-5

Main Imports and Exports in 1964

(as a percentage of total imports
and exports respectively)

Imports		Exports	
Machinery and transport equipment	19	Textiles	16
Minerals, common metals and metal articles	17	Livestock, vegetable products, food, beverages	16
Textiles - raw material and products	13	Wood and wood articles cork and cork products	9
Livestock, vegetable products, food beverage, tobacco	12	Chemical products	5
Chemical products	6	Minerals, common metals and metal articles	5

Source: INE (Anuário Estatístico, 1964).

Table VI-6

Public expenditure on education and culture and its relation to G.N.P. and National Income; 1958-1963

(in millions of current escudos)

	1958	1960	1962	1963
1. Total expenditure	969.6	1,200.8	1,235.8	1,271.6
(i) current	722.8	952.8	1,052.2	1,101.6
(ii) capital	246.8	248.0	183.6	170.0
2. Total expenditure as a percentage of G.N.P.	1.76	1.87	1.69	1.79
3. Total expenditure as percentage of net income	1.86	1.90	1.79	1.72

Source: INE (Anuários Estatísticos, Estatística da Educação, 1964-65)

Table VI-7

Public expenditure by level and type of education; 1958-1962

(percentages)

Type and level of education	Current	Capital	Total	Current	Capital	Total
1. Primary	52.7	26.1	47.2	49.4	32.3	46.8
2. Secondary and Intermediate	35.5	58.2	40.2	38.8	59.9	41.7
General	13.6	-	-	14.2	-	-
Teacher trai-	0.7	-	-	0.7	-	-
Technical and other vocational	18.9	-	-	21.8	-	-
Intermediate	2.3	-	-	2.1	-	-
3. Higher	11.8	15.7	12.6	11.8	7.8	11.5
	100.0	100.0	100.0	100.0	100.0	100.0

Sources: (i) INE (Estatística da Educação, 1964-65.
(ii) Gastos en Educación (by Fernando Mendoza Sanz, O.E.C.D).

Table VI-8

Investment in education (buildings) 1956-1960
(In million escudos at current prices)

	1956		1957		1958		1959		1960	
	mill. esc.	%	mill. esc.	%	mill. esc.	%	mill. esc.	%	mill. esc.	%
1. Primary	74.5	42.2	98.9	52.0	127.7	40.1	142.3	51.3	150.1	46.7
2. Secondary and Intermediate	77.1	43.6	64.6	34.0	129.9	40.9	94.7	34.2	131.2	40.7
General	1.5	0.8	4.5	2.4	30.9	9.9	26.1	9.4	26.4	8.2
Teacher training	-	-	2.5	1.3	2.8	0.8	2.6	1.0	0.2	-
Technical	75.6	42.8	57.6	30.3	96.2	30.2	66.0	23.8	104.6	32.5
Intermediate	-	-	-	-	-	-	-	-	-	-
3. Higher	25.1	14.2	26.6	14.0	60.5	19.0	40.3	14.5	40.5	12.6
Total	176.7	100.0	190.1	100.0	318.1	100.0	277.3	100.0	321.8	100.0

Source: The Treasury, Ministry of Finance (through MRP report)

B. EDUCATION

Trends in education

Tables VI-9 and VI-10

A summary of the basic data available on Education for the school year 1964/1965 is given in Table 2 in the text while the general trend for the period 1946-1964 is summarised in this table. During this period the number of those attending schools increased by well over half a million. Enrolments in primary education, excluding adult courses, dropped from 78.7 per cent of the total in 1946/47 to 68.4 per cent in 1964/1965. During the same period, enrolments in secondary education rose from 13.6 per cent to 23.2 per cent of the total. The ratio between general and technical and other vocational courses showed only a slight variation. In 1964/1965, 51.2 per cent of those enrolled in secondary education were attending technical and other vocational courses. In intermediate education, although the number of students nearly doubled during the 1946-1964 period, the proportion of total enrolments remained at the same low level (0.5 per cent). In higher education the percentage of enrolment is high in general but the proportion of those attending engineering and agricultural courses is relatively low.

Table VI-11

This table includes some enrolment forecasts for the 1964/1974 period, estimated in the MRP Report as the minimum requirements for Portugal to reach its social, economic and educational targets. According to these data, by 1974/75 the six-year compulsory education scheme will be totally imposed, enrolment in secondary education will increase by some 257 per cent and in intermediate education by 660 per cent. In higher education, a drift from academic and other faculties towards scientific and technical is envisaged.

Participation in education

Table VI-12

Participation of population in the various levels of education for the year 1964 is summarised in this table. Of the 7-10 age group, 77.2 per cent were in primary education and 1.5 per cent in secondary education, while of the whole primary and secondary school age population (7-18), 31.8 per cent were in primary education and 19.5 per cent in secondary education.

Output of the educational system

Table VI-13

According to this table the number of graduates from intermediate courses is extremely low; Commercial Institutes granted 70 diplomas in 1964/65 compared with 34 granted in 1950/51 and 94 in 1956/57, while graduation from Industrial Institutes showed a considerable decline over the whole 1950-64 period (70 in 1964/65, 164 in 1950/51). A similar decline is observed in engineering education at university level.

Table VI-14

Of the secondary school graduates in 1964/65, 51 per cent joined directly the labour force, 14 per cent enrolled in intermediate courses and 35 per cent entered higher education institutions. However, according to the MRP study, a completely different picture should evolve within the next decade.

Tables VI-15 to VI-18

Table VI-15 analysis enrolment and output in the Industrial and Commercial Schools by type of course attended for the period 1960-64. Further details are given in Appendix II. Similar data for the Commercial Industrial Institutes and the Agricultural Schools and courses are given in Tables VI-16, VI-17 and VI.18.

Table VI-9

Trends in education - Enrolments by level and type of education

(selected years, 1946/47 - 1964/65)

Level and type of education	1946/47	1955/56	1960/61	1962/63	1964/65
1. Infant	1,812	4,853	6,528	8,039	10,350
2. Primary	593,042	1,086,673	975,621	954,837	955,331
regular (school age)	557,762	829,469	887,235	886,519	894,195
adult	35,280	257,204	88,386	68,318	61,136
3. Secondary	95,725	125,641	220,600	264,197	301,210
general	46,500	68,873	111,821	129,439	144,657
commercial and industrial	41,823	47,825	94,653	118,297	140,329
agricultural	780	712	2,809	5,043	4,390
other vocational(1)	6,622	8,231	11,317	11,418	11,834
4. Teacher training	1,400	2,931	4,756	4,855	3,708
5. Intermediate	2,596	2,215	4,153	4,957	6,170
commercial and industrial	2,596	2,215	3,227	3,845	5,008
agricultural(2)	-	-	654	760	884
nautical	-	-	272	352	278
6. Higher	13,815	18,626	23,877	26,572	31,297
engineering	1,707	1,810	2,312	2,310	2,488
natural sciences and mathematics	3,093	3,150	4,562	5,556	6,129
agriculture	1,001	515	551	594	651
other(3)	8,014	13,151	16,452	18,112	22,029
Total	708,390	1,240,939	1,235,535	1,263,457	1,308,066

(1) Nautical nursing, midwifery, social services, artistic, religious

(2) Farm Management Schools

(3) Letters, law, social sciences, fine arts, medicine, military

Source: INE (Estatística da Educação, 1964/65).

Table VI-10

Trends in education - Percentage enrolment by level and type of education (selected years 1946/47-1964/65)

Level and type of education	1946/47	1955/56	1960/61	1962/63	1964/65
1. Infant	0.3	0.4	0.5	0.6	0.8
2. Primary	83.7	87.5	79.0	75.6	73.0
regular (school age)	78.7	66.7	71.7	70.2	68.4
adults	5.0	20.8	7.3	5.4	4.6
3. Secondary	13.5	10.1	17.9	20.9	23.0
general	6.5	5.5	9.0	10.2	11.0
technical and other vocational	6.9	4.6	8.9	10.7	12.0
4. Teacher training	0.2	0.3	0.4	0.4	0.3
5. Intermediate	0.4	0.2	0.3	0.4	0.5
6. Higher	1.9	1.5	1.9	2.1	2.4
engineering and agriculture	0.4	0.2	0.2	0.2	0.2
science and mathematics	0.4	0.3	0.4	0.4	0.5
other	1.1	1.0	1.3	1.5	1.7
Total	100.0	100.0	100.0	100.0	100.0

Source: Table VI-9.

Table VI-11

Enrolments by level and type of education
Actual 1964 65. Estimated 1969/70, 1974/75

Level and type of education	1964/65		1969/70		1974/75	
	Enrolment	index	Enrolment	index	enrolment	index
1. Infant	10,350	100	18,000	174	24,000	232
2. Primary(1)	894,195	100	834,000	93	800,000	90
3. Secondary	302,094	100	589,000	195	776,000	257
first cycle(2)	104,221(3)	100	330,000	317	387,000	371
general	89,726	100	108,000	120	147,000	164
vocational	108,147(4)	100	151,000	140	242,000	224
4. Teacher training	3,708	100	10,600	288	15,000	405
primary	2,792	100	8,600	308	10,000	359
other(5)	916	100	2,000	218	5,000	545
5. Intermediate	5,008	100	15,000	300	33,000	660
6. Higher	31,575	100	37,000	117	47,000	149
scientific and technical(6)	9,546	100	21,000	220	27,000	283
other	22,029	100	16,000	73	20,000	91

(1) Excluding adults;

(2) compulsory after 1968;

(3) including vocational preparatory cycle;

(4) excluding first cycle preparatory courses;

(5) for infant schools, handicapped children, physical education, secondary schools;

(6) engineering, science and mathematics, agriculture, nautical.

Source: INE (Estatística da Educação, 1964/65); MRP Report.

Table VI-12

Participation in education by age group and level of education, 1964

School population

A = x 1000 B = % of total in the age group

Age group		Infant	primary	secondary and intermediate	teacher training	higher	total
0- 6	A	10.3	54.8	-	-	-	65.1
	B	(0.9)	(5.0)	-	-	-	(1.4)
7-24	A	-	839.4	294.7	3.1	21.8	1,159.0
	B		(28.0)	(9.9)	(0.1)	(0.7)	(38.7)
of which:							
7-10	A	-	670.1	13.4	-	-	683.5
	B		(77.2)	(1.5)	-	-	(78.7)
11-18	A	-	169.3	245.5	0.8	3.7	419.3
	B	-	(13.3)	(19.2)	(0.1)	(0.3)	(32.9)
19-24	A	-	-	35.8	2.3	18.1	56.2
	B	-	-	(4.3)	(0.2)	(0.1)	(4.6)
25 and over	A	-	-	12.4	0.7	9.8	22.9
	B	-	-	(0.3)	(*)	(0.2)	(0.5)
Total		10.3 (0.1)	894.2 (9.8)	307.1 (3.4)	3.8 (*)	31.6 (0.3)	1,247.0 (13.6)

Source: INE (Anuário Estatistico, 1964 and Estatística da Educaçao, 1964/65).

Table VI-13

Examination passes by level and type of education - (selected years, 1950/51-1964/65)

Level and type of education	1950/51	1956/57	1960/61	1962/63	1964/65
Primary	61,972	93,858	132,910	137,801	141,452
Secondary general	13,540	22,254	30,540	35,322	39,370
1st cycle	7,603	12,486			21,300
2nd cycle	4,362	6,764			11,615
3rd cycle	1,575	3,004			6,455
Secondary vocational(1)	5,331	7,778	15,899	19,928	23,390
preparatory cycle	2,115	4,711	11,914	14,665	15,837
Commercial Schools	1,664	1,124	1,314	2,025	3,051
Industrial Schools	1,127	1,026	1,363	1,790	3,063
Agricultural Schools(2)	131	142	120	179	190
other vocational schools(3)	294	775	1,188	1,269	1,249
Intermediate	198	179	128	131	144
Commercial Institutes	34	94	63	60	70(4)
Industrial Institutes	164	85	65	71	74
Higher	1,490	2,095	2,184	2,278	2,704
engineering	264	250	179	163	125
science	151	184	233	263	346
agriculture	51	54	46	47	45
other(5)	1,024	1,607	1,726	1,805	2,188

(1) Including apprenticeship and upgrading courses;

(2) including farm management courses;

(3) nursing, midwifery, social workers;

(4) excluding university preparatory courses;

(5) letters, law, social science, fine arts, medicine.

Source: Instituto de alta cultura (Analise quantitativa da estrutura escolar portuguesa, 1950-59); INE (Estatística da Educação, 1964-65).

Table VI-14

Distribution of the output of secondary schools (1960-1975)

Distribution	1960/61	1964/65	1969/70	1974/75
to:				
active population				
persons	3,970	7,600	17,100	38,500
% of total	43	51	59	66
intermediate education				
persons	1,060	2,100	4,900	10,400
% of total	11	14	17	18
higher education				
persons	4,230	5,300	7,000	9,100
% of total	46	35	24	16
Totals				
persons	9,260	15,000	29,000	58,000
% of total	100	100	100	100

Source: MRP Report.

Table VI-15

Industrial and Commercial Schools - Enrolments and Output; (1960/61-1964/65)

	1960/61	1961/62	1962/63	1963/64	1964/65
Industrial schools	26,659	31,188	36,568	42,316	45,247
Basic full-time training courses	12,550	15,622	18,691	21,983	23,942
Up-grading courses (part-time)	12,223	13,545	15,288	17,343	18,125
Apprenticeship courses	958	976	1,032	1,042	998
"Mastership" courses	284	239	321	290	283
Preparatory to industrial institutes	644	806	1,236	1,658	1,899
Commercial schools	31,825	35,148	39,069	42,420	45,327
Basic courses	14,424	16,421	18,739	21,025	22,701
Up-grading courses (part-time)	15,418	16,553	17,845	18,662	19,953
Apprenticeship courses	1,126	1,136	1,202	1,168	1,108
Preparatory to commercial institutes	857	1,038	1,283	1,565	1,565
	58,484	66,336	75,637	84,736	90,574

Source: INE (Estatística da Educação).

Table VI-16

Commercial Institutes

Enrolments and output; 1952/53, *964/65

Branch	1952/53		1964/65	
	enrolment	output	enrolment	output
Accountancy	*	86	612	64
Correspondence	*	2	24	1
Customs' officers	*	3	-	1
German language	*		104	4
Preparatory to higher education	*	*	797	89
	1,197	*	1,537	159

* Not available

Source: INE (Estatística da Educação).

Table VI-17

Industrial Institutes
Enrolments and output; 1950 to 1964

Branch/establishment	1950		1956		1961		1964	
	enrolment	output	enrolment	output	enrolment	output	enrolment	output
1. Civil engineering and mining	112	46	89	28	122	28	131	32
Lisbon	68	25	63	20	65	13		
Oporto	44	21	26	8	57	15		
2. Electrical and mechanical engineering	231	60	226	35	420	23	817	28
Lisbon	168	20	180	13	255	6		
Oporto	63	40	46	22	165	17		
3. Chemistry and chemical technology	63	21	89	9	137	14	290	14
Lisbon	53	13	62	9	69	11		
Oporto	10	8	27	-	68	3		
Totals	406	127	404	72	679	65	1,238	74

Source: INE (Estatística da Educação).

Table VI-18

Agricultural schools/courses
Establishments, teaching staff, enrolment and output; 1964/65

Level and Branch	No. of establishments	Teaching staff	enrolments	output
1. Preparatory cycle	227	226	243	10
2. Apprenticeship			3,811	49
3. Practical agricultural courses	5	63	336	42
4. Farm management courses	3	67	884	89
5. Courses preparatory to higher institutions			11	1
Totals	235	356	5,285	191

Source: INE (Estatística da Educação).

C. POPULATION AND MANPOWER

The land and the people

Tables VI-19 and VI-20

Portugal with the adjacent islands, covers an area of 91,971 sq. kilometres. The density of population was about 100 inhabitants/sq. kilometre in 1964 as compared with 59.2 in 1900. Total population increased by some 69 per cent during the period 1900 to 1964 and a future 15 per cent increase is envisaged for 1975 (Table VI). A considerable number of Portuguese people emigrate to overseas colonies or other European countries; in 1963 about four out of every hundred inhabitants left the country as against six in 1952. The population, by age group for 1962 and estimates for 1970 and 1975, is given in Table VI-

Active population

Table VI-21

Active population in 1960 was 3,315,639 or 37.9 per cent of the total as against 3,196,482 in 1950 and some 3,660,000 envisaged for 1975. The breakdown of active population by branch of economic sector is given in this Table. During the period 1950-1960 manpower was transferred from primary to secondary and tertiary sectors particularly in construction and manufacturing; this trend is expected to continue for the period 1960-1975.

Table VI-22

Female participation in the labour force is fairly low. In 1960, for instance, only 22.5 per cent of the labour force were women. Although an increase in the absolute number of working women is envisaged for the period 1960-1975, their proportional participation in the labour force will remain more or less constant. Active population as a percentage of the population of the working age is expected to rise by 1975 to 63.5 (98.6 male, 28.9 female), as against 59.7 in 1950 (96.3 male, 25.9 female).

Educational structure of the labour force

Table VI-23

The educational level of the labour force in 1960 was extremely low. Nearly 20 per cent of the active population were illiterate and 67.2 per cent had completed only a primary school course (4 years). Substantial changes, however, are expected to take place during the period 1960-75. By then, the percentage of illiterates will drop to 11, of those with primary school certificate to 50.9 with a corresponding rise in that of secondary, intermediate and higher institution graduates, as shown in this Table.

Table VI-24

A further breakdown of the estimated labour force in secondary and tertiary sectors by occupational category and level and type of education is given in this Table. It is surprising that in occupational category C where technicians, supervisors and foremen are included, only 2.6 per cent have completed intermediate education and 9.2 per cent, secondary technical courses.

Table VI-19

Total population

(Actual, selected years, 1900-1964 - Estimated, 1970, 1975)

Year	Population	Year	Population
1900	5,423,132	1950	8,441,312
1911	5,960,056	1960	8,851,289
1920	6,032,991	1964	9,143,300
1930	6,825,883	1970	9,460,000
1940	7,722,152	1975	9,660,000

Sources: INE (Anuário Estatístico, 1964);
MRP Report.

Table VI-20

Total population by age group

(Actual, 1960 - Estimates, 1970, 1975)

Population in thousands

Age group	1962	1970	1975
0 - 4	901.4	936.6	939.3
5 - 9	851.2	890.0	903.6
10 - 14	839.4	849.4	864.7
15 - 19	747.2	785.5	811.7
20 - 24	705.2	742.1	743.0
25 - 29	673.2	663.4	705.5
30 - 34	637.5	646.4	633.1
35 - 39	591.2	649.5	618.3
40 - 44	499.4	598.1	614.1
45 - 49	510.7	541.6	552.6
50 - 54	481.4	429.5	496.9
55 - 59	409.0	457.9	395.6
60 - 64	334.0	419.3	429.0
65 - 69	264.2	335.7	373.8
70 and over	444.4	515.0	578.8
	8,889.4	9,460.0	9,660.0
of which:			
male	4,254.4	4,512.6	4,603.9
female	4,635.0	4,947.4	5,056.1

Sources: INE (Anuário Estatístico, 1964);
MRP Report.

Table VI-21

Active population by economic sector

Sector	1950		1960		1975 (estimates)	
	persons	% of total	persons	% of total	thousands	% of total
Primary						
Agriculture, forestry and fishing	1,569,120	49.1	1,445,017	43.6	1,280	35.0
Secondary	782,460	24.5	958,707	29.0	1,245	34.0
Mining	25,075	0.8	26,199	0.8	27	0.7
Manufacturing	592,778	18.5	690,880	20.9	940	25.7
Construction and public works	154,685	4.9	227,192	6.9	260	7.1
Gas, electricity and water	9,922	0.3	14,436	0.4	18	0.5
Tertiary	838,960	26.2	890,629	26.8	1,135	31.0
Transport and communications	107,326	3.4	122,150	3.7	162	4.4
Commerce, insurance, real estate	227,674	7.1	270,069	8.1	342	9.4
Other services	503,960	15.7	498,410	15.0	631	17.2
Non identified	5,942	0.2	21,286	0.6	-	-
Total	3,196,482	100.0	3,315,639	100.0	3,660	100.0

Source: INE (Anuario Estatístico - 1960, 1964).

Table VI-22

Active population by sex and its relation to total and working age population

(primary years, 1950-1975)

Year	Population of working age (15-64) thousands	Active population		
		Thousands	% of total population of the corresponding **sex**	% of working age population of the corresp. sex
1950 (actual)	5,363.7	3,196.5	37.9	59.7
male	2,561.7	2,471.9	60.9	96.3
female	2,802.0	724.6	16.5	25.9
1960 (estimated)	5,546.1	3,425.3	37.9	61.7
male	2,731.8	2,655.0	61.3	97.2
female	2.814.3	770.3	16.4	27.4
1965 (estimated)	5,633.0	3,502.5	37.9	62.3
male	2,781.1	2,712.0	61.3	97.5
female	2,851.9	790.5	16.4	27.7
1970 (estimated)	5,700.4	3,577.4	37.8	62.7
male	2,820.6	2,765.1	61.3	98.0
female	2,879.8	812.3	16.4	28.2
1975 (estimated)	5,762.7	3,658.4	37.8	63.5
male	2,859.5	2,818.1	61.2	98.6
female	2,903.2	840.3	16.6	28.9

Source: MRP Report.

Table VI-23

Educational structure of active population;

(1960, 1975)

Level and type of education	1960 (actual)		1975 (estimated)	
	thousands	per cent	thousands	per cent
1. Illiterates	680.8	19.9	402.4	11.0
2. Primary	2,304.2	67.2	1,863.1	50.9
3. Secondary (1st cycle)	198.2	5.8	849.1	23.2
4. Secondary (2nd & 3rd cycles)	166.3	4.9	366.0	10.0
5. Teacher-training (primary)	20.5	0.6	44.0	1.2
6. Intermediate	15.4	0.4	43.9	1.2
7. Higher	41.6	1.2	91.5	2.5
Totals	3,427.0	100.0	3,660.0	100.0

Source: MRP Report.

Table VI-24

Estimated breakdown of the labour force in secondary and tertiary economic sectors (1975) by broad occupational category and by level and type of education

Level and type of education	Occupational category(1)											
	A		B		C		D		E		Total	
	(x 1000)	%	(x 1000)	%	(x 1000)	%	(x 1000)	%	(x 1000)	%	(x 1000)	%
1. Higher												
- completed	21.6	60.3	15.6	91.7	1.3	0.5	-	-	-	-	38.5	2.2
- unfinished	0.5	1.4	0.1	0.6	7.1	2.4	0.3	0.1	-	-	8.0	0.4
2. Intermediate												
- completed	1.5	4.2	0.9	5.3	7.6	2.6	0.2	0.1	-	-	10.2	0.6
- unfinished	0.2	0.6	-	-	9.6	3.3	1.3	0.3	-	-	11.1	0.6
3. Teacher training (primary)												
- completed	0.1	0.3	-	-	20.1	6.9	-	-	-	-	20.2	1.1
- unfinished	-	-	-	-	-	-	-	-	-	-	-	-
4. Secondary general												
- completed	2.4	6.7	0.1	0.6	55.4	19.0	1.4	0.4	4.9	0.5	64.2	3.6
- unfinished	1.1	3.0	0.1	0.6	31.6	10.9	1.8	0.5	10.7	1.0	45.3	2.5
5. Secondary technical												
- completed	2.6	7.2	0.1	0.6	47.1	16.2	9.2	2.4	8.1	0.8	67.1	3.8
- unfinished	1.0	2.8	0.1	0.6	47.5	16.3	38.1	10.1	35.7	3.3	122.4	6.8
6. Primary	4.8	13.4	-	-	62.2	21.4	290.8	77.0	845.3	79.3	1,203.1	67.4
7. Illiterates	-	-	-	-	1.3	0.5	34.4	9.1	160.1	15.1	195.8	10.9
Totals	35.8		17.0		290.8		377.5		1,064.8		1,785.9	

(1) A = Managerial and administrative staff.
B = Senior technical supervisory staff.
C = Technicians, supervisors and foremen.
D = Skilled labour.
E = Unskilled labour.

Source: CEEE Survey/MRP Report.